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JOURNAL

OF THE

FRANKLIN INSTITUTE

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OF THE STATE OF PENNSYLVANIA,

FOR THE PROMOTION OF THE MECHANIC ARTS.

DEVOTED TO

MECHANICAL AND PHYSICAL SCIENCE,

Civil Engineering, the Arts and Manufactures,

AND THE RECORDING OF

AMERICAN AND OTHER PATENT INVENTIONS.

EDITED BY

PROF. JOHN F. FRAZER,

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JULY, 1860.

CIVIL ENGINEERING.

For the Journal of the Franklin Institute.

Double Cylinder Expansion Marine Engines. By ALBAN C. STIMERS, Chief Engineer U. S. Navy.

In the year 1781 Jonathan Hornblower obtained his patent for using two cylinders, one larger than the other, to get the benefit of the expansion of the steam, which, after impelling a small piston with steam of the boiler pressure, was to pass into the large cylinder and act upon the greater number of square inches with a less pressure per square inch, thus rendering the two cylinders approximately equal in power. This was before the days of "patent cut-offs," and indeed the intention of Hornblower was the same as that of the cut-off inventors of the present day, a moderate expansion only was intended, the steam was to follow the small piston during the whole stroke and steam of a very moderate pressure was to be used. After getting his patent, however, he could make no use of it as Watt's claims covered every variety of engine to which such a principle could be applied.

It is noteworthy that this patent of Hornblower's was the first public announcement that there was any benefit to be derived from the expansion of the steam when not flowing freely from the boiler; although Watt had made a practical application of the principle in an engine erected at Soho, near Birmingham, in 1776, five years before, by closing his induction valves before the piston had arrived at the end of the stroke in an ordinary single cylinder engine, as is the common practice at the present day.

Hornblower's mode of effecting the expansion has had many advocates even since the introduction of excellent modes of effecting expansion in a single cylinder, but as a general rule it has only been by amateur engineers, and as a consequence, but few have been actually built.

The only application of them to marine purposes in this country which has fallen under my observation, were those of the steamboats *Independence*, *Oregon*, and *Buckeye State*. The first of these plied upon the Hudson River more than thirty years ago, and had what is known in this country as a square engine. The steam first acted upon two small pistons in vertical cylinders standing one upon each side of a large one, into which the steam passed from both the small cylinders after the completion of the stroke of their pistons. The piston-rods from each of the three cylinders were attached to the same crosshead.

The engine of the *Oregon* was a non-condensing horizontal one, built at Pittsburgh, Pa., in 1847, and the boat plied on our Northern Lakes during five or six years and was finally destroyed by fire in Chicago. The small high pressure cylinder was directly in the rear of the large low pressure one, a piston-rod passing through stuffing-boxes in the rear of the large, and the head of the small cylinder connected the two pistons rigidly together. This was a very awkward arrangement, as the steam, after acting upon the rear side of the small piston, had to traverse a steam pipe after leaving the cylinder, of more than twice the length of the stroke before it could act upon the front side of the large piston.

The following are the dimensions of the cylinders:

Length of stroke . . .	10 ft.
Diameter of large cylinder, . . .	48 ins.
" small " . .	28 "
Ratio of areas, . . .	about 3 to 1.
No. of times the steam was expanded in the small cylinder,	none.
Consequent total number of times the steam was expanded,	three.
Pressure of steam carried in boilers, . .	80 lbs.

Although this engine was unpopular, it is generally acknowledged to have been economical upon fuel.

The *Buckeye State* was built in Cleveland, Ohio, in 1851 as a passenger boat for Lake Erie. The engine, with the exception of the cylinder, was the ordinary condensing, vertical, overhead beam, with lifting air-pump. The small high pressure cylinder was directly within the large low pressure one, which thus had necessarily an annular piston; both pistons were connected to the same crosshead by three piston-rods, one from the central and two from the annular piston. In this arrangement the steam was required to pass through pipes equal in length to the cylinders themselves after leaving the small piston before it could act upon the large one.

The cylinders were of the following dimensions:

Length of stroke, . . .	11 ft.
Diameter of large cylinder, . . .	40 and 80 ins.
" small " . .	37 "
Ratio of areas, . .	3½ to 1.
No. of times the steam was expanded in the small cylinder,	none.
Consequent total number of times the steam was expanded,	3½.
Pressure of steam carried in boilers, . .	50 lbs.

This boat would maintain the same speed as others of the same dimensions running between Buffalo and Detroit on Lake Erie and consume but two-thirds the coal.

The mechanical performances of the engine were excellent, and it won its way through distrust and prejudice to high favor with all classes, and has at last only succumbed to the railroads, the same as all other paddle steamers on the Lakes.

In the course of a cruise in the Frigate *Merrimack*, in the year 1859, on the western coast of South America, I found that an English line of mail steamers—the Pacific Steam Navigation Company—had sent two vessels to England and had the double cylinder expansion engines of Randolph, Elder & Co. put into them, and that the result was a remarkable economy. At Callao the agent of the Company, Mr. Peters, sent an invitation through our Flag Officer for me to visit the Steamer *Callao*, at that time in port, in order that I might learn the particulars of what he believed was a great improvement in steam engineering. I accepted the invitation, and afterwards at Panama, by the polite invitation of Mr. Jameson, the chief engineer of the line, I visited the *Inca*, the *Valparaiso*, and the *Lima*. In the last named I made a trip down the Bay of Panama from the port to Taboga, a distance of nine miles, and thus had an opportunity to thoroughly examine the machinery when in operation. They are of beautiful workmanship, and I think I never saw machinery where the designer had been so entirely successful in combining compactness with easy access to every part requiring attendance, either when running or when overhauling for repairs.

There are two pairs of double cylinders, one forward and one abaft the paddle shaft. They are inclined to an angle with each other of ninety degrees and are direct-acting. There are but two crank-pins, one of which is articulated by the two small high pressure cylinders and the other by the two large low pressure cylinders, two connecting-rods engaging each crank-pin. The two pairs of cranks are directly opposite each other, and the small and large cylinders are side by side. Thus, when the small piston goes up the large one goes down and *vice versa*, making the steam passages from the high to the low pressure cylinders the shortest possible.

DESCRIPTION OF ENGINE.	SPACE OCCUPIED.		WEIGHT.	
	Total.	Per cub. ft. of cylinder.	Total.	Per cub. ft. of cylinder.
	cub. feet.	cub. feet	lbs.	lbs.
The American overhead beam, (1 cylinder,)	14,000	44·408	280,000	885
The side lever, . . "	12,000	38 064	295,000	935
The oscillator, . "	8,000	25·376	220,000	697
The double cylinder expansion (4 cylinders,)	10,000	17 000	448,000	760

Although a strict comparison cannot be made, an idea of their compactness may be formed by the above spaces and weights required in the ship for a single engine. The side lever and oscillator having cylinders 85 inches diameter and 8 feet stroke, and the American beam an equal capacity, but of 70 inches diameter and 10 feet stroke.

The space occupied includes all passages about the engines, but not that part of the overhead beam which is up out of the way above deck.

The small cylinders have induction valves only. They are the gridiron slide with sufficient lap to act as expansion valves. Between the small and large cylinders are slide valves of the ordinary character, without lap, having their faces toward the large cylinders, and when the port is uncovered by the valve the communication is free from the small to the large cylinder at one end and from the large cylinder to the condenser at the other. The cylinders are entirely surrounded with steam from the top of the steam drums of the boilers, where the temperature is from 100° to 150° F. higher than at the surface of the water. This superheating is effected by having steam drums 12 feet in height, with the uptakes from the tubes to the smoke pipe passing through them; the fire surface thus exposed to the steam being about 17·5 per cent. of the total fire surface.

As it may be useful to some readers to know the full dimensions of the vessel, boilers, and engines, I give them complete of the *Lima*, those of the *Valparaiso*, *Callao*, and *Bogota* being essentially the same.

Hull.—Length on deck, 257 ft. Length between perpendiculars, 251 ft. Breadth extreme, 30 ft. Depth of hold, 17 ft. Do. to spar deck, 25 ft. 4 ins. Length of engine space, including bunkers, 71 ft. Do. exclusive of do. 38 ft. 9 ins. Tonnage, (English old measurement,) 1115 44-94 tons. Do. (do. new do.) gross, 1461·24 tons. Do. (do.) engine room, 295·61 tons. Do. (do.) register, 1165 63 tons. Displacement at time of trial, 1345·00 tons. Area of midship section at do. 302 sq. ft. Draft of water at do. forward, 11 ft., aft, 12 ft. Speed at do. 12 knots.

Boilers.—Kind—Multitubular, horizontal fire tube, iron tubes. Number of pieces, two. Length of each, 12 ft. Breadth of each, 9 ft. 6 ins. Height, exclusive of steam drum, 13 ft. 6 ins. Do. inclusive of do. 25 ft. Number of tubes, 516. Diameter of do. outside, 4¼ ins., inside, 4 ins. Length of do, 6 ft. 6 ins. Number of furnaces, 6. Length of grate bars, 6 ft. 6 ins. Breadth of each furnace, 3 ft. 6 ins. Grate surface, 136·5 sq. ft. Fire surface, 3200 sq. ft. Ratio of fire to grate surface, 23·44 to 1. Diameter of smoke-pipe, 5 ft. Height of do. above grate, 45 ft. Cubic contents of water and steam space, 1000 cub. ft. Do. of combustion chambers and furnaces, 480 cub. ft. Air space through fire bars, about 50 sq. ft. Do. through tubes, 50 sq. ft. Do. through smoke-pipe, 19·6 sq. ft. Diameter of uptakes through steam drum, 2 ft. Number of do. six. Surface of do. exposed to steam, 560 sq. ft. Combustion of coal per hour at time of trial, 2590 lbs. Pressure of steam at do. 24 lbs.

Engines.—Kind—Inclined direct-acting, double cylinder expansion. Number of cylinders, four, two high pressure and two low pressure. Diameter of high pressure cylinders, 52 ins. Do. of low do. 90 ins. Ratio of areas, about three to one. Length of stroke, 5 ft. Area of steam passages, (6 × 24,) 144 sq. ins. Condenser, common jet, capacity, 400 cub. ft. Air pump, vertical single acting, lifting, capacity, 17 cub. ft. Vacuum at time of trial, 28 ins. Horses power at time of trial, 1150.

Paddle Wheels.—Kind—Feathering, with Penn's eccentrics and iron floats. Diameter over floats, 25 ft. 2 ins. Length of do. 8 ft. 2 ins. Breadth of do. 3 ft. Thickness of do. ¾-in. Number of do. in each wheel, twelve. Immersion at time of trial, 4 ft. Total weight of engines, 200 tons. Do. of boilers, 50 tons. Do. of water in do. 18 tons. Do. of both paddle wheels, 40 tons. Do. of coal when bunkers are filled, 250 tons.

The *Lima* and *Bogota* were in constant use 9000 miles from England, and were detached from their service in the line and sent this great distance under steam, to have machinery removed which was of modern construction and in every respect mechanically good, to receive new, of a type which had yet to become known to the general engineering profession. Much more than ordinary advantages must be obtained by any engineering improvement to induce so conservative a body as an English steamship company to put themselves to so great an inconvenience and outlay.

The comparative economy of the old and the new machinery of these vessels may be gathered from the following several facts.—

The *Valparaiso*, with the new machinery, burned 640 tons of coal the round trip between Panama and Valparaiso, at the same time that the *Lima* and *Bogota*, with the old machinery, consumed 1150 tons.

The *Lima* was 48 steaming days in going from Callao to Liverpool, and burned 1900 tons of coal. On her return, after being fitted with the new machinery, she steamed only 42 days, and burned but 1000 tons of coal; and her commander, Capt. Wells, informed me that the weather was more favorable on the passage *to* England than on his return.

The *Bogota*, on her first passage out, in April, 1852, averaged on the passage to Madeira 9·75 knots with a consumption of 4256 lbs. of coal per hour. On her passage out, after receiving the new machinery, in September, 1859, she averaged on the passage to St. Vincent, Cape de Verde, 10·42 knots, with a consumption of 2128 lbs. per hour.

The Chief Engineer of the *Lima* informed me that her coal bills for the round trip of 5200 nautical miles, were 7500 dollars less than they were previous to the change in the machinery.

These are the crude facts which establish the great gain in economy of fuel; but, in addition to this, the tonnage of the vessels were considerably increased by the lesser weight and space of the new machinery, and the difference in the coals required to be carried.

It can easily be understood, therefore, why the company, after becoming convinced that the above results could be obtained, should put themselves to such great inconvenience and expense. It is, however, pretty well understood by American engineers, that English marine engines generally, though possessing great mechanical excellence, develop considerably less power per pound of coal than American engines. To enable the American engineer, then, to judge of the propriety of introducing machinery of that character into our steam marine, it is necessary to compare them with one of our most economical American engines. Those of the U. S. Frigate *Saranac* present, perhaps, the best sample that could be taken, as they are thoroughly American engines, and are very economical.

There is no question but that the boilers of the *Saranac* and those in general use in our navy at the present time, are decidedly superior to those which have been furnished to the Pacific Steam Navigation Company, by Randolph, Elder & Co. The question is, therefore, solely between the two kinds of engines.

To make a strict comparison between engines, independent of the boilers, it is necessary to compare the power obtained with the water required to be evaporated. This can be done with little difficulty from correctly-taken indicator diagrams from engines in good working order. There is also a great advantage in this mode of comparison, in that no dependence is required to be placed upon the observations of those in attendance, always liable to be more or less erroneous, and in that it is not necessary to take a mean of a large number of diagrams: the examination of one set giving accurate results for the conditions which exist at the time they are taken.

The *Saranac* was completed in 1849. The engines were designed by C. W. Copeland, Esq., and built by Jabez Coney, of Boston. She originally had flue boilers of copper; but the great success of the *Martin Vertical Water Tube Boiler* led to their removal and the introduction of the latter type in 1857. Her engines, however, remain unchanged, except in the cut-off gear, which is quite unimportant in an economical point of view. The following are the dimensions of the vessel, boilers, and engines.—

Hull.—Length over all, 237 ft. Length between perpendiculars, 215 ft. Breadth, extreme, 38 ft. Depth of hold, 23 ft. 6 ins. Tonnage (Custom House measurement), 1440 tons. Draft of water at deep load, 17 ft. 9 ins. Displacement at above draft, 2290 tons. Area of midship section at above draft, 540 sq. ft. Speed in smooth water at sea with 393·5 horses power, 7 knots.

Boilers.—Kind—Martin's patent vertical water tube; brass tubes. Number of pieces, two. Length of each, 10 ft. 6 ins. Breadth of each, 20 ft. 5 ins. Height of each, exclusive of steam drum, 11 ft. 3 ins. Do., inclusive of do., 13 ft. 3 ins. Number of tubes, 2860. Diameter of do., inside, 1 8-10 ins., outside, 2 ins. Length of do., 2 ft. 9 ins. Number of furnaces, 12. Length of grate bars, 6 ft. Breadth of each furnace, 2 ft. 9½ ins. Grate surface, 201 sq. ft. Fire surface, 6009 sq. ft. Ratio of fire to grate surface, 30 to 1. Diameter of smoke-pipe, 6 ft. 4 ins. Height of do. above grate, 60 ft. Air space through fire-bars, about 80 sq. ft. Do. through tube boxes, 27·5 sq. ft. Do. through smoke-pipe, 31·5 sq. ft.

Engines.—Kind—Inclined direct-acting. Number of cylinders, two. Diameter of do., 60 ins. Length of stroke, 9 ft. Condenser, common jet. Air pump. Inclined piston pump.

Paddle Wheels.—Kind—Common radial; wooden floats. Diameter over floats, 27 ft. 6 ins. Length of floats, 9 ft. Breadth of do., 2 ft. 6 ins. Number of do. in each wheel, 22. Immersion at above draft, 6 ft. 4 ins.

The cylinders of the *Saranac* are well surrounded by felt and wooden lagging, but there are no steam jackets; neither is the steam superheated.

The following are the observed conditions at the time the diagrams in the adjoining plate were taken. The engines of the *Valparaiso* differ from the others in not having the cylinders surrounded with steam, except in the cylinder bottoms of large cylinders, and in all cylinder covers. These diagrams were taken from the engines when doing their ordinary every-day work; it being the rule, both in our navy and in that line of steamers, to take one complete set each day, and place them on file. One-half only of each set examined are given in the plate.

The curved lines drawn upon the diagrams, marked M, show the true expansion curve, according to the law of Mariotte. Those marked R in the diagrams from the *Saranac*, show the modification of MARIOTTE'S law, which is effected by the slight superheating of the steam during expansion, according to the laws of steam as given by REGNAULT. The dotted lines along the expansion curves of the diagrams, represent the true pressure in the cylinder.

	SARANAC.	VALPARAISO.	CALLAO.
Pressure of steam in the boilers, .	12 lbs.	19½ lbs.	18 lbs.
Vacuum in the condenser, .	26 ins.	26 ins.	26 ins.
Position of throttle valve, . .	Wide open.	4 ins. open.	
Temperature of hot-wells, .	110° F.		
Pounds of coal used per hour, .	1470	2240	1960
Kind of coal, . .	Anthracite.	Scotch, Welsh, & patent fuel.	
Per centum of ashes and clinker, .	21	15	15

When the induction valve is closed and the pressure suddenly commences to fall, the indicator piston is a little behind-hand in its movements, and then when it does start, its momentum carries it a little too far. In applying the dotted line, I have been compelled to rely entirely upon my experience and judgment in such matters. If any engineer thinks they are incorrect, he can easily retrace them to suit himself, and modify my results accordingly.

DIAGRAM No. 1.

a	*b*	*c*	*d*	*f*	*g*	*h*	*k*
Part of Stroke.	Pressure by MARIOTTE'S Law.	Corresponding Temperature.	Corresponding total heat required to maintain the pressure in column *b*.	Total heat actually in the steam.	Difference available for superheating the steam, *f—d*.	Increase of pressure due to this superheating.	Consequent actual pressure, *b+h*.
	lbs. sq. in.	F °.	F °.	F °.	F °.	lbs. sq. in.	lbs. sq. in.
Commencement,	25·	241·	1187·47	1187·47	0·	0·	25·
$\frac{1}{8}$	25·	241·	1187·47	1187·47	0·	0·	25·
A $\frac{1}{4}$	22·	233·8	1185·16	1187·47	2·31	0·125	22·125
$\frac{3}{8}$	14·666	211.89	1178·61	1187·47	8·86	0·264	14·930
$\frac{1}{2}$	11·	197·54	1174·03	1187·47	13·44	0·301	11·301
$\frac{5}{8}$	8·8	187·39	1170·67	1187·47	16·80	0·301	9·101
$\frac{3}{4}$	7·333	175·57	1168·53	1187·47	18·94	0·283	7·616
$\frac{7}{8}$	6·285	172·63	1166·39	1187·47	21·80	0·279	6·564
End,	5·5	168·1	1165·17	1187·47	22·30	0·250	5·750
DIAGRAM No. 2.							
Commencement,	26·25	243·85	1188·32	1188·32	0·	0·	26·25
$\frac{1}{8}$	26·25	243·85	1188·32	1188·32	0·	0·	26·25
$\frac{1}{4}$	26·25	243 85	1188·32	1188·32	0·	0·	26·25
A 5-16	25 625	......	......	......	......	......	......
$\frac{3}{8}$	21·354	232·12	1184·74	1188 32	3·58	0·155	21·509
$\frac{1}{2}$	16·015	216·30	1179·92	1188·32	8·40	0·273	16·288
$\frac{5}{8}$	12·812	205·	1176·47	1188·32	11 85	0·309	13·121
$\frac{3}{4}$	10·677	196·13	1173·77	1188·32	14·55	0·316	10·993
$\frac{7}{8}$	9·152	189·74	1171·82	1188 32	16·50	0·307	9·459
End.	8·008	183·2	1169·82	1188·32	18·50	0·301	8·309

To obtain the expansion curve of MARIOTTE, the pressure was measured on the diagram at A and the calculations are made as if the stroke commenced at the line B; the space between that and the commencement of the diagram being the length of the cylinder which would be equal in capacity to the clearance between the valves and the piston at the end of the stroke. It will be observed that the measurement of the pressure at A for a *point d'appui* of the expansion curve is exactly what is effected by the correction of the line traced by the indicator shown by the dotted line.

As I have observed in a recent publication that Regnault's expositions of the laws of steam are sometimes misunderstood, I give in the foregoing table the exact method by which Regnault's curve of expansion has been found in the two diagrams from the *Saranac* given in the plate.

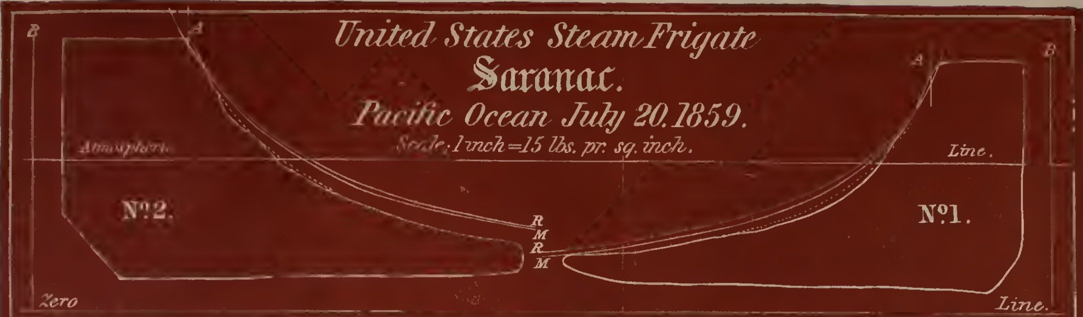
The temperatures in column *c* were taken from the well known table of the pressures and temperatures of steam given in all engineering pocket-books. Where the pressures in column *b* were not found exactly in the table, the increase of temperature between the next higher and next lower tabular pressure was assumed to be proportional to the increase of pressure, which is not rigorously true, but is nearly so, for the small differences employed. The total heat required to maintain the pressure, column *d*, was taken from Regnault's tables. Where the temperature in column *c* were not found exactly in the table the difference was obtained between the given and the next lower tabular temperature, and this multiplied by 0·305 gave accurately the amount which was required to be added to the tabular total heat. The increase of pressure was obtained upon the rule of Regnault that it was doubled by the addition of 494° Fahr.

From this table it would appear that where the heat of the steam is neither increased nor diminished by extraneous influences, any expansion of the steam causes it to be superheated and not condensed, as some have erroneously asserted, basing their assertion upon the laws of steam as given by Regnault.

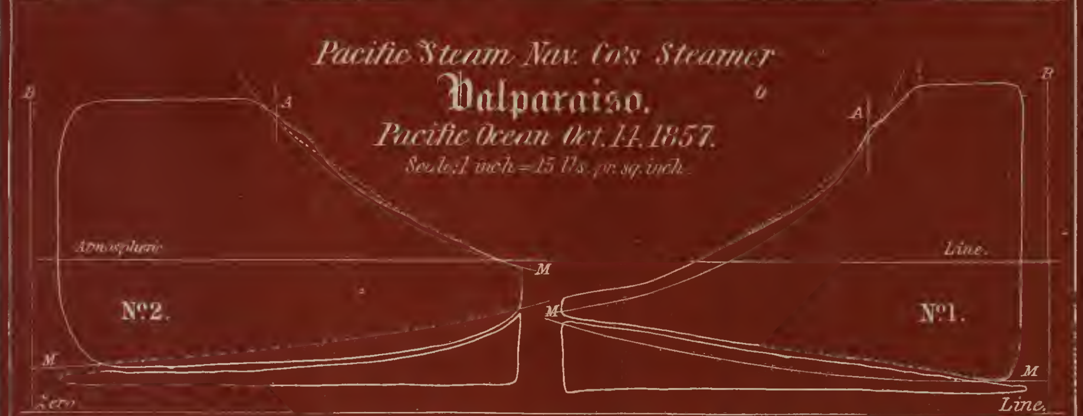
A little reflection must also convince any one not carried away by a kind of scientific fanaticism that the yielding of the piston in the cylinder to the pressure upon it affects the steam only by giving it an opportunity to expand. What then becomes of Prof. Joule's theory that condensation is caused by a rendition of power on the part of the steam? It is painful to know that such absurd doctrines are advanced by men of learning and position, and that they are proved to be correct, and adopted into the calculations of others equally learned and high in position.

In the subjoined tables will be found the calculations of the diagrams from the engines of the three vessels compared, tabulated in such a way as to enable any engineer to judge of the correctness of the results obtained and to insert his own corrections at the proper point wherever he may consider it necessary.

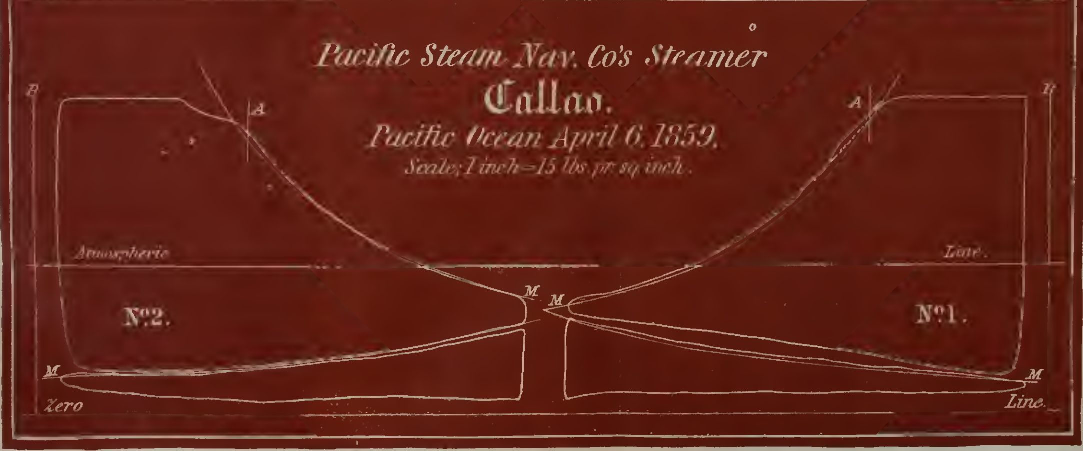
In obtaining the amount of steam condensed in the cylinders of the *Saranac* before the point of cutting off, I was necessarily compelled to assume that the cylinder remained constantly at the same temperature during the different fluctuations of the steam within it—as to attempt a calculation of the amount of its fluctuations during the stroke would be a refinement which I consider is much better left out of all investigations of this kind. If it could be accurately known and employed the result of the calculation would be a greater amount of condensation previous to cutting off than has been arrived at in the table. Because, when the steam first entered the cylinder the temperature of



United States Steam Frigate
Saranac.
Pacific Ocean July 20. 1859.
Scale; 1 inch = 15 lbs. pr. sq. inch.



Pacific Steam Nav. Co's Steamer
Valparaiso.
Pacific Ocean Oct. 14. 1857.
Scale; 1 inch = 15 lbs. pr. sq. inch.



Pacific Steam Nav. Co's Steamer
Callao.
Pacific Ocean April 6. 1859.
Scale; 1 inch = 15 lbs. pr. sq. inch.

the latter is below the mean, but when the piston is at the commencement of the ¼ stroke which has been taken for a measure of the condensation, the metallic surfaces with which the steam is in contact has been heated to a temperature above the mean, and during this ¼ stroke its temperature is still going up, so that the difference between the temperatures of the steam and the surfaces with which it is in contact is not so great during the above ¼ stroke as between the steam and the mean temperature of the cylinder given in the table. The condensation per unit of surface and unit of difference in temperature is, therefore, greater than that arrived at in the table. At the same time the difference between the temperatures of the steam and the surfaces with which it comes in contact before cutting off is greater than between the steam and the mean temperature of the cylinder, so that this greater condensation per unit should be multiplied by a greater difference of temperature than is given in the table.

In calculating the condensation of the different diagrams the unit in the fifth column only was used.

One-fourth only of the stroke was used to find the unit for calculating the condensation and that taken immediately after the starting point of the expansion curve of the diagrams, because during the latter part of the stroke the temperature of the steam gets below that of the cylinder and the condensation not only ceases but evaporation takes place, which is not only very reasonable, but may be observed in the diagrams of the *Saranac* given in the plate, while during the ¼ stroke made use of the temperature of the steam was always above that of the cylinder.

The loss by blowing off has been taken at about the average of sea-going ships when the existence of scale is ignored, and the same for all. It is put into the account of the engines because it is an attachment of the engines and not of the boilers which prevents this loss.

In computing the number of times the steam is expanded the ratio is found between the space filled with steam at the point of cutting off and the space filled at the end of the stroke. The steam really expands as much more than this as there is condensation beyond the point of cutting off. That is, however, a kind of expansion that requires no "precedents" to prove it unbeneficial.

In calculating the diagrams of the *Valparaiso* and *Callao* I labored under the difficulty of not knowing the amount of space in the clearances of the piston and the steam passages. I estimated this amount for the small cylinders to be equal to 3½ inches in length of cylinder for the upper end and 4 inches for the lower end. This may appear large until it is remembered that these cylinders have, not only the ordinary induction passages, but in addition there are the peculiar eduction passages to the large cylinders, within which, as in a steam chest, are the slide valves of the large cylinders. With regard to the clearances in the large cylinders I was guided entirely by the amount which the pressure of the steam fell at the end of the stroke of the small piston and the commencement of the stroke of the large piston, as shown by the diagrams accounting the spaces filled to be inversely as the pressures indicated.

TABLE *showing the Method employed and Results obtained in Calculating the Economy of the Engines of the Saranac.*

	Diagram No. 1.	Diagram No. 2.	Diagram No. 3.	Diagram No. 4.	The four diagrams combined.
Pressure in pounds per square inch of the steam in the cylinder at the point of cutting off,	25·	26·25	24·5	23·6	
Cubic feet of space in cylinder and clearances filled with steam of the above pressure,	41·0365	57·2678	43·2945	55·9589	
Number of revolutions made by the engines per minute,	12·	12·	11·5	11·	
Relative volume of saturated steam of the above pressure and water,	1044·	1015·	1064·	1101·	
Pounds of water in the form of steam of the above pressure, at the time of cutting off, per hour,	1768·8	2580·	1754·75	2081·4	8184·95
Total heat in saturated steam of the above pressure, F.°	1187·47	1188·32	1187·11	1186·36	
do do atmospheric pressure, F.°	1178·6	1178·6	1178·6	1178·6	
Additional number of pounds which the same heat would therefore evaporate to atmospheric pressure,	13·2	21·	11·75	13·6	59·55
Mean temperature of steam during the full stroke of the piston, F.°	200·	211·19	196·95	200·4	
do do forming the back pressure during the return stroke of the piston, F.°	142·64	153·24	144·41	146·4	
Consequent mean temperature of the cylinder, F.°	176·76	176·76	172·04	172·04	
Mean temperature of the steam during the ¼ stroke of piston next after the point A of the diagrams, F.°	209·8	221·4	213·	215·2	
Difference between temperature of steam and mean temperature of cylinder during the above ¼ stroke, F.°	33·04	44·64	40·96	43·16	
Number of pounds weight of steam condensed per hour in the above ¼ stroke,	291·1	300·	248·5	240·2	
Number of square feet of surface in contact with the steam at the commencement of the above ¼ stroke,	92·49	105·77	92·49	105·77	
do do do do end do do	129·77	143·05	129·77	143·05	
Mean do do during do do	111·13	124·41	111·13	124·41	
Fraction of complete revolution made by the engine do do do	·094	·089	·094	·089	
Number of pounds weight of steam condensed per hour per unit of surface and unit of difference in temperature	·8434	·6069	·5807	·5026	·6334
Difference between temperature of steam and mean temperature of cylinder before the point of cutting off, F.°	64·24	67·09	67·86	65·7	
Mean number of square feet of surface in contact with the steam before cutting off,	32·51	42·75	36·96	42·	
Fraction of complete revolution made by the engine from the commencement of the stroke until steam is cut-off,	·14	·1722	·1444	·17	
Number of pounds weight of steam condensed in the cylinder before cutting off, to be added to the evaporation given above,	185·19	312·83	229·38	297·13	1024·53
Number of pounds weight of steam which represent 12 per cent. loss by blowing off to keep the saturation down in the boilers,	268·25	397·34	272·16	326·2	1263·95
Total number of pounds weight of steam which represent the heat expended upon the engines per hour in obtaining the power,	2235·44	3311·17	2268·04	2718·33	10532·98
Number of times the steam is expanded in the cylinder,	4·54	3·28	4·3	3·35	3·79
Mean effective pressure on the piston in pounds per square inch,	9·6	13·52	9·7	11·	
do do would have been if there had been no condensation in cylinder after steam was cut off,	10·38	14·72	10·66	12·2	
Consequent per centums of loss of useful effect by condensation in cylinder after steam was cut off,	7·52	8·15	9·	9·83	8·63
Per centums of the steam actually evaporated, condensed in the cylinder before cutting off,	9·41	10·73	11·49	12·42	11·05
Total per centums of loss by condensation in the cylinder,	16·93	18·88	20·49	22·25	19·68
Mean back pressure on the piston in pounds per square inch,	2·8	3·52	2·85	3·07	3·08
Per centums of loss of useful effect by back pressure,	22·58	20·65	22·70	21·84	21·94
Horses power developed upon the piston,	89·1	12·51	86·	93·3	393·5
Number of pounds weight of steam which represent the heat expended upon the engines per hour per H. P.	25·089	26·468	26·372	29·135	26·767

TABLE *showing the Method employed and the Results obtained in Calculating the Economy of the Engines of the Pacific Steam Nav. Co.'s Steamers,*

	VALPARAISO.					CALLAO.				
	Diagram No. 1.	Diagram No. 2.	Diagram No. 3.	Diagram No. 4.	The four diagr'ms combi'd.	Diagram No. 1.	Diagram No. 2.	Diagram No. 3.	Diagram No. 4.	The four diagrams combined.
Pressure in pounds per square inch of the steam in the small cylinder previous to cutting off,	32·1	30·25	32·5	30·25		31·5	31·	32·25	30·	
Cubic feet of space in small cylinder and clearances filled with steam of the above pressure,	23·7	36·4	23·965	36·4		35·333	30·11	31·09	28·65	
Number of revolutions made by the engine per minute,	20·5	20·	20·5	20·		19·5	19·5	19·5	19·5	
Relative volume of saturated steam of the above pressure and water,	831·	877·	821·	877·		845·	857·	827·	883·	
Pounds of water in the form of steam of the above pressure at the time of cutting off, per hour,	2193·	3112·87	2244·	3112·87	10662·74	3057·5	2569·2	2749·3	2372·75	10748·75
Total heat in saturated steam of the above pressure, F.°	1192·	1190·83	1192·2	1190·83		1191·54	1191·26	1191·98	1190·66	
do do atmospheric pressure, F.°	1178·6	1178·6	1178·6	1178·6		1178·6	1178·6	1178·6	1178·6	
Additional number of pounds which the same heat would therefore evaporate to atmospheric pressure,	25·	32·13	25·8	32·13	115·06	33·5	27·6	41·2	24·25	116·55
Number of pounds weight of steam condensed in steam jackets of cylinders, allowing 1·94 per cent, to be thus condensed,	43·88	62·22	44·9	62·22	213·22					
Number of pounds weight of steam condensed in steam jackets of cylinders, allowing 5 per cent. to be thus condensed,						162·68	136·67	146·34	126·16	571·85
Number of pounds weight of steam which represent 12 per cent. loss by blowing off to keep the saturation down in the boilers,	308·43	437·34	315·64	437·34	1498·75	443·68	372·74	399·11	344·06	1559·6
Total number of pounds weight of steam which represent the heat expended upon the engines per hour in obtaining the power,	2570·31	3644·56	2630·34	3644·56	12489·77	3697·36	3106·21	3225·95	2867·22	12996·75
Number of cubic feet of space filled with steam at the end of stroke of large piston,	239·	254·8	239·	254·8		244·	248·	244·	248·	
Number of times the steam is expanded in the cylinders,	10·08	7·	9·97	7·	8·19	6·76	8·23	7·84	8·65	7·86
Mean effective pressure on small piston in pounds per square inch,	15·24	19·03	14·75	19·03		15·	16·725	16·675	15·175	
do back do do do	6·25	5·53	7·42	5·53		7·	5·825	7·925	5·7	
Per centums of loss of useful effect by back pressure on small piston,	29·1	22·5	23·46	22·5		31·8	25·8	32·2	27·3	
Mean effective pressure on large piston in pounds per square inch,	3·4	2·32	3·34	2·32		3·625	3·675	4·037	3·25	
do back do do do	2·34	2·7	3·2	2·7	2·73	2·5	1·875	2·75	2·125	2·56
Per centums of loss of useful effect by back pressure on large piston,	40·7	53·7	49·	53·7		40·8	33·6	40·5	39·5	
do do do in the two cylinders combined,	34·9	38·1	41·23	38·1	38·	36·3	29·7	36·35	33·4	33·95
Pressure in pounds per square inch of small piston, which it is estimated would overcome the friction of itself and its immediate connexions,	1·25	1·25	1·25	1·25		1·25	1·25	1·25	1·25	
Horses power developed upon the small piston,	100·53	122·46	97·3	122·46	442·75	94·118	104·942	104·628	95·216	398·904
do do do after the above friction is deducted,	92·29	114·42	89·06	114·42	410·19	86·245	97·069	96·755	87·343	367·412
do do large piston,	67·18	44·72	66·	44·72	222·62	68·135	69·075	76·	61·185	274·395
Total horses power, with the extra friction, inherent to double cylinder engines, deducted,	159·47	159·14	155·06	159·14	632·81	154·38	166·144	172·755	148·528	641·807
Number of pounds weight of steam which represent the heat expended upon the engines per hour, per horse power,	16·117	22·901	16·963	22·901	19·737	23·301	18·696	18·673	19·304	20·25

The clearances of the *Saranac* are equal to 6 inches length of cylinder at the upper end and 6·8 inches at the lower end.

In obtaining the weight of the water evaporated from the diagrams of the *Valparaiso* and *Callao* I have treated it as though saturated steam was used; this gives a slight excess of the true amount of even that which would be evaporated by the heat contained in it, but the error is very small, and could not be corrected because the exact amount which the steam was superheated at the time the diagrams were taken is not noted on them, and I am informed that it varies considerably at different times.

It is estimated by English engineers familiar with the steam jacket, that five per cent. of the steam raised in the boiler is condensed in the jacket. This amount appears rather small when the great number of expansions are considered, but it must not be forgotten that the steam is superheated both when entering the cylinder and the jacket. Mr. Jameson was intending to ascertain by direct experiment how much was thus condensed, but when I left the Pacific it had not yet been done. The bottoms of the large cylinders and all cylinder covers being the only steam jackets around the cylinders of the *Valparaiso* amount to 38·8 per cent. of their whole surface, and 5 per cent. of this is (38·8 × ·05 =) 1·94 per cent.

Collecting the data contained in the foregoing we have the following results and comparisons between the engines *per se*, the boilers *per se*, and of them both combined.

ACTUAL PERFORMANCES.	Saranac.	Valparaiso.	Callao.	Mean between Valparaiso and Callao.
Pounds of steam required per hour per H. P.,	26.767	19·735	20·25	19·993
Pounds of water evaporated per lb. of coal,	7.165	5·575	6·631	6·103
" " per lb. of combustible, . . .	9·070	6·597	7·807	7·202
Pounds of coal required per hour per H. P.,	3·735	3·540	3·054	3·297
" combustible " "	2·911	3·010	2·596	2·803
RELATIVE PERFORMANCES.				
Ratio of power obtained per unit of water evaporated, . .	1·000	1·356	1·321	1·338
Ratio of water evaporated per unit of coal consumed, . . .	1·000	0·778	0·922	0·850
Ratio of water evaporated per unit of combustible consumed, .	1·000	0·728	0·860	0·793
Ratio of power obtained per unit of coal consumed, . .	1·000	1·055	1·223	1·139
Ratio of power obtained per unit of combustible consumed, .	1·000	0·967	1·121	1·044

From this exhibit it would appear that there is no doubt about the superiority of the *engines* of the *Valparaiso* and *Callao* over those of the *Saranac*, but in comparing the two sister vessels together we get the best results from the engines which are only partially steam jacketed, but it is evident from the appearance of the diagram from the top end of the cylinder (*Valparaiso* No. 1) that the induction valve leaked, and the evaporation given in the tables is therefore deficient to the extent of the leak.

As the same coals were used in both vessels the true evaporation per pound of coal is very probably nearly the same.

The ratio of excellence of the *engines* of the two vessels, as per the above table, stands:

Valparaiso 1·000; *Callao* 0·974.

But if the same amount of water is really evaporated by the boilers of each, the ratios would stand:

Valparaiso 1·000; *Callao* 1·154.

They would then compare with the *Saranac* as follows:

Saranac 1·000; *Valparaiso* 1·138; *Callao* 1·321.

It is evident from the tables that a much greater economy could be obtained from these engines by simply increasing the pressure, so that the per cent. of loss by the back pressure in the large cylinder would be reduced. In the *Valparaiso* this is now 49·1 and in the *Callao* 38·6. To double the pressure would reduce this loss one-half. This could be done without much increasing the pressure in the boilers by permitting the steam to follow the small piston farther. It will be observed that the horses power of the small cylinders is the greatest in each case; if, therefore, they were to follow the small piston far enough to make the power of the large piston a little the greatest it would of itself reduce the above loss considerably, while the loss by the diminished number of times the steam would be expanded, would be comparatively very small.

Report of the Committee on Gas Works, presented to the Select and Common Councils of the City of Philadelphia, April 19, 1860.

To the Select and Common Councils of the City of Philadelphia.

The Committee on Gas Works, to whom were referred the following resolutions, viz:

"*Resolved*, By the Select and Common Councils of the City of Philadelphia, that the Committee on Gas Works be instructed to inquire and report whether the manufacture of gas from any materials other than those now in use at the Philadelphia Gas Works, is practicable; and if so, whether such gas can be manufactured at a cheaper rate than is now charged, and if so, at what rate; and whether such gas gives an equal or greater degree of light than that manufactured from coal; and if thought practicable, what cost will be incurred in change of apparatus, &c., and any other information relative to the subject, which they may deem important.

"*Resolved*, That they be further instructed to inquire and report from what cause (if it can be ascertained,) the bills of consumers of gas have been, of late, so largely increased; whether from defective meters, or from inferior quality of gas furnished, or from other causes.

"*Resolved*, That the Committee be instructed to report at as early a day as convenient."

Respectfully report—That, in reference to the first resolution, the Committee are not, as yet, prepared to report.

In pursuance of the second resolution, directing inquiry into the cause of the recent increase in the amount of gas bills, it seemed right for the Committee first to ascertain whether the increase referred to, had any existence, in fact.

For this purpose, a statement has been compiled from the Bill Books of the Gas Offices, exhibiting all the bills issued in the months of December, January, and February, during four successive years, to all consumers, who, for that time, have continued to use gas in the same premises, in the wards comprising the old city proper, Moyamensing, Spring Garden, Penn Township, and West Philadelphia.

This statement comprises the bills of 11,114 consumers, to whom more than 44,000 bills were issued during the four winters.

It appears that the bills of 3259 of the consumers, or not quite one-third, are higher in the last winter than in those of the three previous years, and the bills of 7855, or rather more than two-thirds, are not higher than those for previous years.

The aggregate amount of all the bills to these consumers, in the winter of

1856–57	was	$138,177·70
1857–58	"	125,762·24
1858–59	"	137,923·36
1859–60	"	141,368·54

the increase of 1859–60, over 1856–57, being $3190·84, or about 2¼ per cent.

The reports of the Inspectors of fittings show that in the interval between 1856 and 1859, the number of additional lights, put on by the consumers included in the foregoing statements, is 8300, or about 6 per cent. increase of lights, if these customers are supposed to have in use the average number of lights, which is shown by the published reports to be twelve to each consumer.

From this it appears, that the amount of gas used has not increased as much as the number of lights in use; and a similar result is exhibited by comparing the whole quantity of gas sold in the year with the whole number of lights in use at the beginning of the year. For example, the number of lights reported to Councils, as in use in January, 1856, was 300,406, and the cubic feet of gas sold in that year was 415,888,950, being 1384 feet to each light. The lights reported in use in January, 1859, was 378,462, and the cubic feet of gas sold in that year was 494,128,345, being 1305 feet to each light, or 5½ per cent. less than before.

These comparisons have been carried back so as to include four years in order to avoid the erroneous conclusions which would result from taking only the past two years, which included a period of commercial depression, the effects of which are very marked upon the consumption of gas by certain classes of consumers; among whom the various manufacturers present very conspicuous examples; while among other classes not thus affected by business, the quantity of gas consumed has been curiously regular, sometimes the bills for three or four successive winters not materially varying in amount, and in thousands of instances not differing so much as one dollar for several years. The aggregate amount of the bills for the periods of commercial distress, and also the average consumption per light in use, are shown to be diminished in a remarkable degree, and gives strong confirmation to the other proofs elicited by this laborious investigation, of the carefulness and accuracy with which the books and accounts of the City Gas Trust are kept.

The table of annual consumption per light, compiled from the published reports to Councils, shows the average amount of gas used per light to be less in 1859 than in any other of the eighteen years elapsed since the City has owned the Gas Works, except 1857 and 1858, when the consumption was so much reduced by the suspension of business.

In addition to the statements exhibiting the foregoing facts, relating only to consumers who have been supplied during four successive years, two others have been prepared, embracing all those consumers who have used gas during the last two winters, in Southwark and Kensington.

These comprise two bills for each of 3408 consumers, amounting to 6816 bills, and make an aggregate of more than 50,000 bills, whose amounts, making a total of $543,231·84, have been examined and compared in this investigation.

In the first named district the gas was derived from the City Works during both winters; but in the former season, received only an inadequate supply, in consequence of the imperfect communication between the local main of the Southwark Gas Company, and those of the City, from which the supply was drawn; which defects were removed in the summer of 1859.

The aggregate of the bills here, on the 1st of March, 1859, was $10,652·79, and in March, 1860, was $11,683·24, the increase being $1030·45, or not quite 10 per cent.

In Kensington, the bills rendered by the Northern Liberties Gas Company, on the first of April, 1859, amounted to $12,573·42; and those by the City Gas Works, to the same consumers for the corresponding period in 1860, amount to $10,224·74, the former amount being greater by $2348·68, or 22 per cent. over the latter.

Part of this gain to the people of Kensington, results from the lower price now paid per one thousand cubic feet; but the books show that nearly one-half of it is in the saving of gas consumed, which is nearly 10 per cent. less since their supply from the City Works. It is proper to remark, in this connexion, that the saving to the City of cost of gas for public lighting, by the purchase of the Kensington Gas Works, is about $5000 a year; while the quantity of light in the streets is generally greater since the change in the source of the supply.

In Southwark, out of 1618 bills rendered, 1029 were larger in 1860, than in 1859, and 589 were not larger.

In Kensington, out of 1790 bills rendered, 378 bills were larger in 1860, than in 1859, and 1412 were not larger.

The unavoidable conclusion to which the Committee has arrived, after a careful consideration of the foregoing facts, is that there has been no general increase in the amount of gas bills, nor any local increase that is not evidently the result of an increased facility of supply; and moreover, that an examination of the accounts of the many thousands of gas consumers kept in the offices of the City gas trust will satisfy every unbiased mind as to the regularity and reliability of the records of consumption given by the instruments used for the measurement of gas.

The voluminous statements compiled from the bill books for the use of the Committee are kept open to the inspection of any member of Councils, and indeed of any citizen, who may desire to examine them, and thus form his own judgment as to the accuracy of the statistics that have been derived from their critical analysis.

WM. ROTCH WISTER,
WILSON KERR,
J. E. ELDRIDGE,
GEORGE READ,

Committee on Gas Works.

CHARLES T. JONES,
WM. BRADFORD,
O. H. P. PARKER,
STEPHEN BENTON,

Philadelphia, April 19th, 1860.

RECAPITULATION.

CITY.

First Section. North of the North Side of Market Street, from Delaware to Schuylkill, due February 1,

1857	1858	1859	1860
$34,115·70	$30,262·73	$34,286·45	$34,516·75

Second Section. From North Side of Market Street to South Side of Walnut Street (inclusive) from Delaware to Schuylkill Rivers, due December 1,

1856	1857	1858	1859
$29,554·60	$26,319·92	$28,617·36	$30,253·20

Third Section. South of the South Side of Walnut Street to South Street (inclusive) from Delaware to Schuylkill Rivers, due January 1,

1857	1858	1859	1860
$31,306·77	$29,674·85	$32,487·00	$32,040·10

Monthlies. From Vine Street to South Street (inclusive) from Delaware to Schuylkill Rivers, due

	1856–7	1857–8	1858–9	1859–60.
December 1,	$4483·64	$4107·41	$4729·48	$4670·58
January 1,	4438·14	4882·41	4728·81	4849·50
February 1,	5380·71	4245·81	4446·30	4690 25
Total,	$14.302·49	$13,235·63	$13,904 59	$14,210·33

SPRING GARDEN.

First Section. East of Twelfth Street and North of Vine Street, all Streets running North and South, due December 1,

1856	1857	1858	1859
$5977·56	$5728·48	$6131·75	$6711 95

Second Section. East of Twelfth Street, and North of Vine Street, all Streets running East and West, due January 1,

1857	1858	1859	1860
$6916 86	$6532·86	$7113·91	$7378·35

Third Section. West of Twelfth Street, all Streets North of Vine Street, due February 1,

1857	1858	1859	1860
$8551·41	$6903·45	$8300·76	$8929·51

Monthlies. North of Vine Street, from Sixth Street, &c., to Schuylkill River, due

	1856–7	1857–8	1858–9	1859–60
December 1,	$503·97	$474·73	$517·26	$551·25
January 1,	675·04	654·32	613·35	619·43
February 1,	552·35	559·36	567·21	604·47
Total,	$1731·36	$1688·41	$1697·82	$1775·15

MOYAMENSING.

Due, Dec. 1st,

1857	1858	1859	1860
$1251·89	$4036·33	$3970·95	$4104·00

WEST PHILADELPHIA.

Due,	1857	1858	1859	1860
January 1,	$919·33	$879·80	$872·82	$901·82
February 1,	546·73	503·73	539·95	547·38
	1466·06	1383·53	1412·77	1449·20
Total,	$138,177·70	$125,762·24	$137,923·36	$141,368·54
Grand Total,		$543,231·84		

KENSINGTON.

Due, April 1st,

1859 1860 1859 1860

$12,573·42 10,224·74 cubic feet 5,029,370 cubic feet 4,544,328

or about 22 per cent. more in 1859 than in 1860.

378 bills greater in 1860 than in 1859.
1403 " less " "
9 " identical " with "

Total, 1790 Bills.

SOUTHWARK.

Due, March 1st,

1859	1860
$10,652·79	$11,683·24

1029 bills greater in 1860 than in 1859.
473 " less " "
116 " identical " with "

Total, 1618 Bills.

SUMMARY.

Showing the proportion of bills in the last winter, that are greater, or less, or identical with those of previous years.

	Greater.	Less.	Identical.	Total.
Old City Proper,	1979	4550	851	7380
Spring Garden,	1070	1401	491	2962
Moyamensing,	164	331	101	596
West Philadelphia,	46	101	29	176
Total,	3259	6383	1472	11,114

Number of instances of Identical Bills in the four years.

	2 Bills.	3 Bills.	4 Bills.
Old City Proper,	1559	88	43
Spring Garden,	822	55	39
Moyamensing,	169	9	13
West Philadelphia,	45	5	2
Total. . .	2595	157	97

Year.	Lights in use January 1st.	Gas sold during the year.	Cubic feet per light.
1842	21,996	49,888,830	1995
1843	28,080	47,565,751	1693
1844	31,557	53,631.156	1699
1845	36.682	54,076,598	1746
1846	42,558	74.547,300	1751
1847	50,792	89.700,993	1766
1848	66.822	105,663.050	1581
1849	84,523	134.003,850	1583
1850	110,591	181,267.500	1639
1851	129.027	195,212,325	1517
1852	143,441	209,574.250	1461
1853	168,381	248,120,995	1473
1854	200.848	279.307,174	1340
1855	222.989	293,800,915	1313
1856	300.406	415,888,950	1384
1857	338.592	432,052,884	1276
1858	357,729	444,631,979	1242
1859	378,462	494,128,345	1305

*On the Efficiency of various kinds of Railway Brakes; with Experimental Researches on their Retarding Powers.** By Mr. W. FAIRBAIRN, M. Inst. C. E.

The present communication was based upon an inquiry which arose out of a report prepared by Col. Yolland, R. E., for the Railway Department of the Board of Trade. That report gave the results of a large number of experiments, with heavy trains at high velocities, made with the steam brake of Mr. McConnell, the continuous brake of Mr. Fay, the continuous and self-acting brake of Mr. Newall, and the self-acting brake of M. Guérin. The conclusions arrived at being favorable to the brake of Mr. Newall, as well as, partially, to that of M. Guérin, for some descriptions of heavy traffic, Mr. Fay made application to the directors of the Lancashire and Yorkshire Railway, for a further investigation of the subject. This permission was granted, and the author agreed to arrange the conditions of the trial, and to superintend the experiments.

*From Newton's London Journal, May, 1860.

The objects the author had in view were—first, to ascertain the respective retarding power of each of the competitive brakes; and, secondly, to obtain some data in regard to the rapidity with which a train, with an engine and tender attached, could be brought to a stand, when traveling at a high rate of speed; so as to determine the value of the continuous and self-acting brakes, as compared with those ordinarily in use, and with others recently introduced. To enable this comparison to be made, the experiments were reduced to a common standard, by means of a few dynamical laws, which were explained.

It was stated that, in the increase of the braking power of trains, the principles hitherto most successfully employed, had been,—first, the use of steam acting direct on the brakes; second, the connexion of several of the ordinary form of brakes, so as to have them under the control of a single brakesman; and, third, the introduction of braking apparatus connected with the buffers, so as to make the momentum of the train itself available in generating a retarding force.

A description was then given of the different brakes before alluded to as having been experimented upon by Colonel Yolland. It was mentioned, that Mr. Newall claimed the earlier application of a combination of brakes, acted upon by one guard through a longitudinal shaft; and that Mr. Fay had adopted the same principle, with very slight modification, either in form or in construction.

The mode of carrying out the experiments with Mr. Newall's and Mr. Fay's continuous brakes was then detailed, and the results obtained were recorded in seven tables, one for each set of trials. As, in the reductions, the value of the retarding force of the brakes was found in terms of the co-efficient of friction of the rubbing surfaces, the efficiency of the brake varied with the condition of the weather. Thus, the mean of the Oldham experiments gave a retarding force of 1·7987 feet per second; the mean of the first experiments at Southport 4·2978, and of the second 3·3245. On each day the experiments were consistent with one another, but they varied greatly, on different days, from the change in the condition of the rubbing surfaces. At Oldham, the experiments were made with the rails in a greasy condition from fog; at Southport, in the first trial (Table 2), with the rails dry, and in the best state for braking, and in the second (Table 3), with the rails slightly wet. These results were in accordance with the experiments of Morin, on the friction of iron on iron, from which it was found that the co-efficient of friction varied from 0·05 to 0·3, according as the surfaces were greasy, wet, or dry. The remaining experiments were all made under the most uniform and favorable conditions. They were, therefore, grouped together under the following heads:—

1. On the friction of the carriages (Table 4).
2. With slide brakes, and the engine detached (Table 5).
3. With flap brakes, and the engine detached (Table 6).
4. With the engine attached to the train (Table 7).

The following table gave a brief summary of all the experiments except those on the friction of the carriages, which was found to amount to 11·527 lbs. per ton weight of train in Mr. Fay's case, and to 7·627 lbs. per ton in that of Mr. Newall :—

	No. of Experiments.		Average efficiency of Brake.	
	Mr. Fay.	Mr. Newall.	Mr. Fay.	Mr. Newall.
Oldham Incline, Table 1,	7	7	1·8538	1·7136
Southport " " 2,	5	1	3·6256	4·9700
" " " 3,	1	1	3·2329	3·4161
" " " 5,	8	8	6·7030	5·4984
" " " 6,	3	3	5·8718	6·3272
" " " 7,	3	3	3·0934	3·0250

The general average from this table gave, for the efficiency of Mr. Fay's brake, 4·0634, and for Mr. Newall's, 4·1650, showing a slight superiority in favor of the latter. The following conclusions seemed to be borne out by the experiments :—1. That with slide brakes, the greater number of experiments gave a manifest superiority to Mr. Fay. 2. That with flap brakes, there was a decided advantage on the side of Mr. Newall. 3. That when the train was braked, with the engine attached, the results were uniform, neither gaining any decided superiority.

Colonel Yolland's experiments were then tabulated, and reduced in the same manner as the author's, so as to admit of comparison with them. The results thus arrived at, in reference to two of the systems, were exhibited in the annexed summary :—

	Mr Newall.	Mr. Fay.	Remarks.
Engine Detached, .	3·5516 3·017	3·9345 3·255	Dry. Wet.
Engine Attached,	4·671 5·146 4·505	......	Mean 4·774.

The final reduction of the retarding force, to units of weight of the brake carriages, was given in the following general summary :—

Brake.	Weather.	Experimenters.	Ratio of Weight on the Brakes to the Retarding Force generated by them, or the Mean Co-efficient for each Brake.
Mr. Newall's, .	Dry.	Fairbairn.	From 0·1544 to 0·1965
" .	Wet.		0·0542
Mr. Fay's, . .	Dry.		From 0·1126 to 0·2082
" .	Wet.		0·0576
Mr. Newall's, .	Dry.	Yolland.	From 0·1116
Mr. Fay's, .	Dry.		0·1020
Mr. Ingram's, .	Wet.		0·1075
M. Guérin's, .	Dry.		0·01048
Mr. McConnell's, .			02·8325

Showing that the retarding force varied from the one-hundredth to five-eighteenths of the weight of the carriages to which brakes were applied, and was ordinarily from one-tenth to one-fifth.—*Proc. Inst. Civ. Eng.* April 17, 1860.

MECHANICS, PHYSICS, AND CHEMISTRY.

*On Platinum and its associated Metals.** By MM. Deville and H. Debray.

The *Annales de Chimie et de Physique* for August last contains a very elaborate article by the above chemists on the subject of platinum and the metals which accompany it. The results at which they have arrived are so important, and they are moreover of such interest, that we are induced to lay before our readers a few of the principal facts contained in their memoir.

The metallurgy of platinum is altogether a modern art, the introduction of the metal into the laboratories of science and industry dating but from a few years back; and although particularly deserving the attention of the chemist, the metallurgy of platinum and its congeners is, in general, but little known. Except for chemical purposes, platinum has not hitherto received any important application; but when we know better where to look for its ores, and when the deposits already known are more extensively worked, the ores of platinum will, perhaps, become no rarer than gold; and as the metal is almost indestructible, and as its value protects it from losses and accidents of all kinds, it must in time accumulate and thus become more plentiful. It may then perhaps be applied to other useful purposes in which its weight and slightly tarnished color will be no objection, or for which its absolute unalterability will give it a peculiar value. The solution of these questions, however, depends on the price for which the metal can be supplied; and the chemist is particularly interested in seeing its cost so far reduced that the large vessels of the laboratory may be made of platinum. It was in the hope of facilitating a progress of this kind, that MM. Deville and Debray undertook the difficult researches the results of which are given in the above-mentioned memoir, a work which has cost them more than four years of labor.

Until the first communications of M. Deville were published, no one dreamt of utilizing all the metals found with platinum, and with the exception of palladium and osmium, which there was always a motive for separating, platinum alone has been extracted from the ores, leaving a residue which has accumulated in all the manufactories in Europe as well as in the Russian Mint.

The processes described are exclusively by the dry way, and by fusion at a very high temperature. They are given in different chapters, which treat of "the revivification of pure platinum," "the metallurgy of pure platinum," "the extraction from the rough ore of a triple alloy of platinum, rhodium, and iridium of a suitable and invariable composition;" and lastly, the extraction, whether from the residues or from the osmide of iridium, of the utilizable metals, platinum, palladium, rhodium, and iridium.

We give first, the methods practised for obtaining pure platinum, reserving for a future occasion the interesting accounts of the individual metals, and the methods for assaying the rough ores, metals, and residues.

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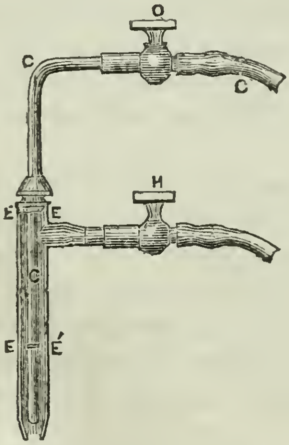
*From the Lond. Chemical News, No. 1.

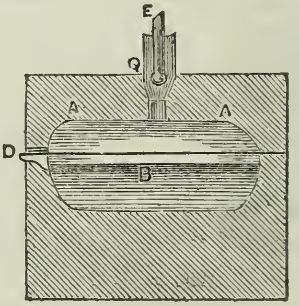
In commerce, platinum is found which is almost free from iridium, but which still contains traces of osmium and a little silicium. MM. Deville and Debray have discovered that fusion in lime by means of an oxidizing flame, refines it perfectly, osmic acid being disengaged, and the silicium becoming converted into silicate of lime, which melts into a colorless bead, and moves rapidly about on the surface of the metal until it reaches the edge, where it is absorbed by the sides of the furnace. Platinum so melted and refined is a metal as *soft* as copper; it is whiter than ordinary platinum, and does not possess the porosity which has hitherto been an obstacle to the manufacture of an impermeable platinum sheath.

Melted platinum still possesses the property of condensing gases at its surface, and of producing the phenomenon of a lamp without flame. Its density = 21·15—less than the density of ordinary platinum which has been subjected in the working to a powerful hammering (*d'un écrouissage extrêmement energique*).

We now proceed to describe the apparatus by means of which platinum has been melted, in quantities relatively considerable, and run into ingots, like a metal of ordinary fusibility.

The fuel most often employed has been common coal-gas, but hydrogen may be used, and when pure will give even a greater heat. The combustion is fed by a current of oxygen. The furnace in which the fusion is made, is of lime bound with iron wire. It is composed of two parts: 1, The roof A A, made of a cylindrical piece of lime slightly arched on its lower surface, and pierced by a conical hole Q, through which a blowpipe C E is to pass; and, 2, a bottom B, made of another piece of lime, hollowed as shown in the diagram. The hollow should be scooped out so deep, that the melted platinum may occupy a depth of 3 or 4 millimetres or more. At the anterior part D, a groove inclined a little towards the inside is made with a file, which is to serve as a hole for the metal to run out of and for the flame to issue from.





The blow-pipe is composed of a copper cylinder E E, terminated at its lower extremity by a slightly conical tube E′ E′, made of platinum.

A copper tube C C, having a platinum nozzle, enters the first cylinder at its upper extremity, and is so arranged as to allow the nozzle to be slid up or down, and placed at any height from the lower end of the cylinder E E E′ E′, that may be wished.

A stop-cock H, is attached to the side of the cylinder E, by means of a tube as large as the cylinder itself. Another stop-cock O, terminates the elbow of the tube C. It is by the stop-cock H, that the hydrogen or coal gas passes, and the oxygen is introduced through the stop-cock O.

When the fusion is to be made, the pieces of lime composing the furnace are put together in the way represented in the diagram. Then, holding the blow-pipe in the hand, the stop-cock H, is opened so as to allow the passage of a gentle stream of gas which is lighted, and the stop-cock O, is turned to admit the oxygen necessary for the combustion. The flame is in this way plunged into the apparatus by the hole Q, in such a manner as to avoid an explosion, which might disturb the pieces of lime. The body of the furnace is now gradually heated; the quantity of the gases passing being increased by degrees until the maximum temperature is attained. The degree of heat may be raised or lowered as need be, by raising or lowering the platinum nozzle which supplies the oxygen. The temperature is now lowered, and the platinum is introduced, by little and little, through the opening D. When it is in thin slips of less than a millemetre in thickness there is scarcely time to introduce them. They are seen to melt and disappear almost at the moment they enter the furnace. The oxygen should arrive at a regular pressure of about four or five centimetres of mercury, and ought to give a rotary movement to the platinum so as to equalize the temperature throughout the mass.

When it is not wished to run the metal into a mould, the fusion being perfect, and the refining completed, which is the case when no more vitreous matter is seen to form on the surface, the two gases are turned off by degrees, always leaving the oxygen in a decided but very slight excess. The mass now gradually solidifies, and the flame may be completely extinguished. A little of the metal is always thrown up to the roof of the furnace, where it may be easily collected after the operation is finished.

When the platinum is to be cast, an ingot mould is prepared of thick cast iron, well rubbed with plumbago, or of coke or lime. The last are most easily made of plates of the substance, sawn, and held together by iron wire. The roof of the furnace is taken off, the body seized with a pair of tongs, and the platinum is poured out, without hurrying, just as we should any other metal. The only difficulty which occurs, and this a little practice will enable the operator to overcome, is to discern at the same time the dazzling surface of the metal and open mouth of the mould, before turning up the crucible. A larger quantity than 3 or 4 kilogrammes should never be cast in this way, inasmuch as there would be great danger of some part of the apparatus giving way.

For greater quantities, the authors describe how a larger furnace may be made of several pieces of lime bound firmly together with iron; an ingenious and simple arrangement, by means of which the metal may be poured out without taking up the bottom part of the apparatus. The reasons they give for preferring to use lime in the construction of the furnace are as follows:—

1. Lime is perhaps the worst conductor of heat known; so much so, that through a thickness of at most 2 centimetres (0·8 inch), the apparatus being full of melted platinum, the temperature of the outside is barely 120° (Cent.)

2. Lime radiates heat most perfectly. For this reason it is the best material for the sides of a reverberatory furnace of this kind.

3. Lime acts on all the impurities from which we wish to free platinum—iron, copper, silicium, &c., changing them into fusible compounds, which are absorbed by its porous substance. It acts like a cupel, the material purifying the metal melted in it.

An experiment made in the laboratory of the *Ecole Normale* showed that the quantity of oxygen required to melt 1 kilogramme (2·2 lbs. Avoird.) of platinum was only 60 litres (about 13 gallons), the cost of which was estimated at 0·4 of a franc. The cost of the coal gas or hydrogen used was not considered worth taking into account.

The process applied to the revivification of old platinum gives excellent results. No foreign metal except iridium and rhodium can exist in platinum after it has been melted and refined in the method described. All the substances which most easily attack platinum, sulphur, phosphorus, arsenic, gold, soda, iron, copper, palladium, and osmium, are separated either by oxydation and absorption by the lime or by volatilization. Gold and palladium escape in the form of vapor, and may be easily collected by making the flame which issues from the furnace pass through an earthenware tube, in which will be deposited all the volatile matters except the osmic acid, which may be condensed if the vapor is made to pass over a vessel full of ammonia. A part of the osmium is also deposited in the tube in a metallic state.

The only caution to be observed in the process is never to have the bath of metal of more than 4 or 5 centimetres thickness without keeping it in constant agitation; because the platinum is too bad a conductor to remain perfectly liquid if it is in greater depth; and, therefore, there will be a chance of the refining not being complete, or of the perfect fusion of the mass not being quite effected.

Coal Oil as a preservative for Sodium and Potassium.

The following statement is sent to us by an anonymous correspondent.

To the Editor of the Journal of the Franklin Institute.

Coal oil is a better article for preserving sodium and potassium than naphtha. In coal oil, sodium keeps its lustre for months or years; while, in the purest naphtha, it loses it in a few days.

Yours, &c., A. C.

Philadelphia, May 22, 1860.

A Course of Six Lectures (adapted to a Juvenile Auditory), consisting of Illustrations of the Various Forces of Matter, i.e. *of such as are called the Physical or Inorganic Forces—including an Account of their Relations to each other.** By M. Faraday, D. C. L., F. R. S., Fullerian Professor of Chemistry, R. I., Foreign Associate of the Academy of Sciences, Paris, &c.

Lecture I. (Dec. 31, 1859.)—*The Force of Gravitation.*

It grieves me much to think that I may have been a cause of disturbance in your Christmas arrangements, for nothing is more satisfactory to my mind than to perform that which I undertake; but such things are not always left in our own power, and we must submit to circumstances as they are appointed; I will to-day do the best I can; I will ask you to bear with me if I am unable to give more than a few words; and as a substitute I will endeavor to make the *illustrations* of the sense I try to express, as full as possible; and if we find by the end of this lecture that we may be justified in continuing them, thinking that next week our power shall be greater—why then, with submission to you, we will take such course as you may think fit; either go on or discontinue them; and although I now feel much weakened by the pressure of illness (a mere cold) upon me, both in faculty of expression and clearness of thought, I shall here claim, as I always have done on these occasions, the right of addressing myself to the younger members of the audience,—and for this purpose, therefore, unfitted as it may seem for an elderly infirm man to do so, I will return to second childhood and become, as it were, young again amongst the young.

Let us now consider, for a little while, how wonderfully we stand upon this world. Here it is we are born, bred, and live, and yet we view these things with an almost entire absence of wonder to ourselves respecting the way in which all this happens. So small, indeed, is our wonder, that we are never taken by surprise; and I do think, that, to a young person of ten, fifteen, or twenty years of age, perhaps the first sight of a cataract or a mountain would occasion more surprise in him than he had ever felt concerning the means of his own existence; how he came here; how he lives; by what means he stands upright; and through what means he moves about from place to place. Hence, we come into this world, we live, and depart from it, without our thoughts being called specifically to consider how all this takes place; and were it not for the exertions of some few inquiring minds, who have looked *into* these things and ascertained the very beautiful laws and conditions by which we *do* live and stand upon the earth, we should hardly be aware that there was any thing wonderful in it. These inquiries, which have occupied philosophers from the earliest days, when they first began to find out the laws by which we grow, and exist, and enjoy ourselves, up to the present time, have shown us that all this was effected in consequence of the existence of certain *forces* or *abilities* to do things, or *powers*, that are so common that nothing can be commoner; for nothing is commoner than the wonderful powers by which we are enabled to stand upright—they are essential to our existence every moment.

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* From the Lond. Chemical News, No. 5.

Now, it is my purpose to-day to make you acquainted with some of these powers; not the vital ones, but some of the more elementary, and, what we call, *physical* powers; and in the outset, what can I do to bring to your minds a notion of neither more nor less than that which I mean by the word *power* or *force?* Suppose I were to take this sheet of paper, and were to place it upright on one edge resting against a support before me, (as the roughest possible illustration I can give of something to be disturbed), and suppose I pull this piece of string which is attached to it. I pull the paper over. I have, therefore, brought into use a *power* of doing so—the *power* of my hand carried on through this string in a way which is very remarkable when we come to analyze it; and it is by means of these powers conjoined together (for there are several powers here employed) that I pull the paper over. Again, if I give it a push upon the other side, I bring into play a *power*, but a very different exertion of power from the former; or, if I take now this bit of shellac [a stick of shellac about 12 inches long and 1½ in diameter] and rub it with flannel, and hold it an inch or so in front of the upper part of this upright sheet, the paper is immediately moved towards the shellac, and by now drawing the latter away, the paper falls over without having been touched by anything. You see—in the first illustration I produced an effect than which nothing could be commoner—I pull it over now, not by means of that string or the pull of my hand, but by some action in this shellac. The shellac, therefore, has a *power* with which it acts upon the sheet of paper; and as an illustration of the exercise of another kind of power, I might use gunpowder with which to throw it over.

Now, I want you to endeavor to comprehend that when I am speaking of a *power* or *force*, I am speaking of that which I used just now to pull over this piece of paper. I will not embarrass you at present with the *name* of that power, but it is clear there was a *something* in the shellac which acted by attraction, and pulled the paper over; this, then, is one of those things which we call *power* or *force;* and you will now be able to recognise it as such in whatever form I show it to you. We are not to suppose that there are so very many different powers; on the contrary, it is wonderful to think how few are the powers by which all the phenomena of nature are governed. There is an illustration of another kind of power in that lamp; *there* is a power of heat—a power of doing something, but not the same power as that which pulled the paper over; and so, by degrees, we find that there are certain other powers (not many) in the various bodies around us; and thus, beginning with the simplest experiments of pushing and pulling, I shall gradually proceed to distinguish these powers one from the other, and compare the way in which they combine together. This world upon which we stand (and we have not much need to travel out of the world for illustrations of our subject; but the mind of man is not confined like the matter of his body, and thus he may and does travel outwards, for wherever his sight can pierce, there his observations can penetrate,) is pretty nearly a round globe, having its surface disposed in a manner of which this terrestrial globe by my side is a rough model; so much is land and so much is water, and by looking at it here we see in a sort of map or picture how the world is formed upon its surface. Then, when we come to examine further, I refer you to this sectional diagram of the geological strata of the earth, in which there is a more elaborate view of what is under the surface of our globe. For, when we come to dig into or examine it (as man does for his own instruction and advantage, in a variety of ways), we see that it is made up of different kinds of matter, subject to a very few powers; and all disposed in this strange and wonderful way, which gives to man a history—and such a history—as to what there is in those veins, in those rocks, the ores, the water springs, the atmosphere around, and all varieties of material substances, held together by means of *forces* in one great mass, 8000 miles in diameter, that the mind is overwhelmed in contemplation of the wonderful history related by these strata (some of which are fine and thin like sheets of paper),—all formed in succession by the forces of which I have spoken.

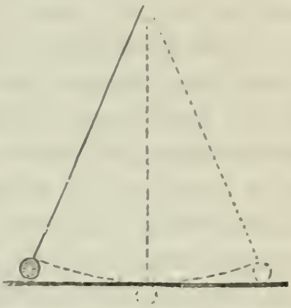
Now, I shall try to help your attention to what I may say, by directing, to-day, our thoughts to one kind of power. You see what I mean by the term *matter*—any of these things that I can lay hold of with the hand, or in a bag (for I may take hold of the air by enclosing it in a bag)—they are all portions of matter with which we have to deal at present, generally or particularly, as I may require to illustrate my subject. Here is the sort of matter which we call *water*—it is *there* ice [pointing to a block of ice upon the table]—*there* water [pointing to the water boiling in a flask]—*here* vapor—you see it issuing out from the top [of the flask]. Do not suppose that that ice and that water are two entirely different things, or that the steam rising in bubbles and ascending in vapor *there* is absolutely different from the fluid water—it may be different in some things, having reference to the *amounts* of power which it contains; but it is the same, nevertheless, as the great ocean of water around our globe, and I employ it here for the sake of illustration, because if we look into it we shall find that it supplies us with examples of all the powers to which I shall here refer. For instance, here is water—it is heavy; but let us examine it with regard to the *amount* of its heaviness or its gravity. You see here I have a little glass vessel and scales [nearly equipoised scales, one of which contained a half-pint glass vessel], and the glass vessel is at present the lighter of the two; but if I now take some water and pour it in, you see that that side of the scales immediately goes down; that shows you (using common language, which I will not suppose for the present you have hitherto applied very strictly), that it is *heavy*, and if I put this additional weight into the opposite scale, I should not wonder if this vessel would hold water enough to weigh *it* down. [The Lecturer poured more water into the jar, which again went down.] Why do I hold the bottle *above* the vessel to pour the water into it? You will say, because experience has taught me that it is necessary. I do it for a better reason —because it is a law of nature that the water should fall towards the earth, and, therefore, the very means which I use to cause the water to enter the vessel are those which will carry the whole body of water down. That power is what we call *gravity*, and you see *there* [pointing to the scales] a good deal of water gravitating towards the earth. Now *here* [exhibiting a small piece of platinum] is another thing which gravitates towards the earth as much as the whole of that water. See what a little there is of it—*that* little thing is heavier than so much water [placing the metal in opposite scales to the water]. What a wonderful thing it is to see that it requires so much water as *that* [a half pint vessel full] to fall towards the earth, compared with the little mass of substance I have *here;* and again, if I take this metal [a bar of aluminium about eight times the bulk of the platinum], we find the water will balance that as well as it did the platinum; so that we get, even in the very outset, an example of what we want to understand by the words *forces* or *powers.*

I have spoken of water, and first of all of its property of falling downwards—you know very well how the oceans surround the globe—how they fall round the surface, giving roundness to it, clothing it like a garment; but, besides that, there are other properties of water. *Here*, for instance, is some quick-lime, and if I add some water to it, you will find another power or property in the water. It is now very hot, it is steaming up, and if I had a bit of phosphorus here, or a match, I could perhaps light it. Now that could not happen without a *force* in the water to produce the result; but that force is altogether very different from its power of falling to the earth. Then, again, here is another substance [some anhydrous sulphate of copper] which will illustrate another kind of power. [The Lecturer here poured some water over the white sulphate of copper, which immediately became blue, evolving considerable heat at the same time.] Here is the same water with a substance which heats nearly as much as the lime does, but see how differently. So great indeed is this heat in the case of lime, that it is sufficient sometimes (as you see here) to set wood on fire; and this is the reason of what we have sometimes heard, of barges laden with quick-lime taking fire in the middle of the river, in consequence of this power of heat brought into play by a leakage of the water into the barge. You see how strangely different subjects for our consideration arise, when we come to think over these various matters—the power of heat evolved by acting upon lime with water, and the power which water has of turning this salt of copper from white to blue.

I want you now to understand the nature of the most simple exertion of this power of matter called *weight* or *gravity.* Bodies are heavy—you saw that in the case of water when I placed it in the balance. Here I have what we call a *weight* [an iron half cwt.]—a thing called a weight, because in it the exercise of that power of pressing downwards is especially used for the purposes of weighing; and I have also one of these little inflated india-rubber bladders which are very beautiful although very common (most beautiful things are common), and I am going to put the weight upon it, to give you a sort of illustration of the downward pressure of the iron, and of the power which the air possesses of resisting that pressure—it may burst, but we must try to avoid that. [During the last few observations the Lecturer had succeeded in placing the half cwt. in a state of quiescence upon the inflated india-rubber ball, which consequently assumed a shape very much resembling a flat cheese with round edges.] There you see a bubble of air bearing half a hundred weight, and you must conceive for yourselves what a wonderful *power* there must be to pull this weight downwards, to sink it thus in the ball of air.

Let me now give you another illustration of this power. You know what a pendulum is. I have one here (Fig. 1.), and if I set it swinging, it will continue to swing to and fro. Now, I wonder whether you can tell me why that body oscillates to and fro—that pendulum bob as it is sometimes called. Observe, if I hold this straight stick horizontally, as high as the position of the ball at the two ends of its journey, you see that the ball is in a higher position at the two extremities than it is when in the middle. Starting from one end of the stick, the ball falls towards the centre, and then rising again to the opposite end it constantly tries to fall to the lowest point, swinging and vibrating most beautifully, and with wonderful properties in other respects—the time of its vibration and so on—but concerning which we will not now trouble ourselves.

Fig. 1.

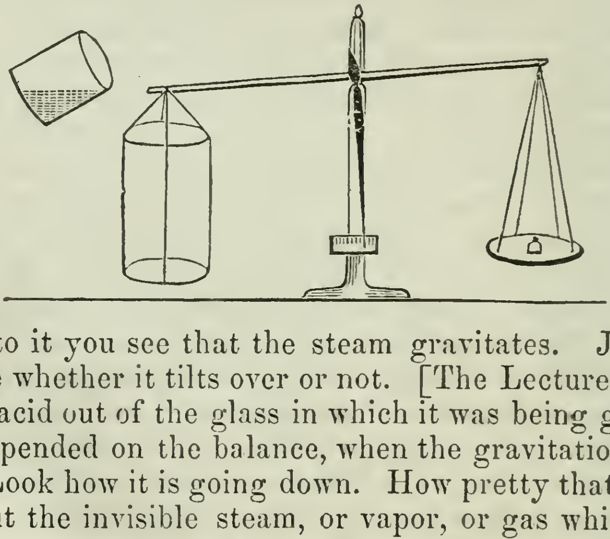


If a gold leaf, or piece of thread, or any other substance, were hung where this ball is, it would swing to and fro in the same manner and in the same time too. Do not be startled at this statement; I repeat, in the same manner and in the same time, and you will see by-and-by how this is. Now, that power which caused the water to descend in the balance—which made the iron weight press upon and flatten the bubble of air—which caused the swinging to and fro of the pendulum, that power is entirely due to the attraction which there is between the falling body and the earth. Let us be slow and careful to comprehend this. It is not that the earth has any *particular* attraction towards bodies which fall to it, but, that *all* these bodies possess an attraction, every one towards the other. It is not that the earth has any special power which these balls themselves have not, for just as much power as the earth has to attract these two balls [dropping two ivory balls], just so much power have they in proportion to their bulks to draw themselves one to the other; and the only reason why they fall so quickly to the earth is owing to its greater size. Now, if I were to place these two balls near together I should not be able by the most delicate arrangement of apparatus, to make you, or myself, sensible that these balls did attract one another; and yet we know that such is the case; because if, instead of taking a small ivory ball, we take a mountain, and put a ball like this near it, we find that, owing to the vast size of the mountain as compared with the billiard-ball, the latter is drawn slightly towards it; showing clearly that an attraction *does* exist, just as it did between the shellac which I rubbed and the piece of paper which was overturned by it.

Now, it is not very easy to make these things quite clear at the outset, and I must take care that I do not leave anything unexplained as I proceed, and, therefore, I must make you clearly understand that all bodies are attracted to the earth, or, to use a more learned term, *gravitate*. You will not mind my using this word, for when I say that this penny piece *gravitates*, I mean nothing more nor less than that it falls towards the earth, and if not intercepted, it would go on falling, falling, until it arrived at what we call the *centre of gravity* of the earth, which I will explain to you by-and-by.

I want you, now, to understand that this property of gravitation is never lost, that every substance possesses it, that there is never any change in the quantity of it; and, first of all, I will take as illustration a piece of marble. Now this marble has weight—as you will see if I put it in these scales; it weighs the balance down, and if I take it off, the balance goes back again and resumes its equilibrium. Now I can decompose this marble and change it, in the same manner as I can change ice into water and water into steam. I can convert a part of it into *its own* steam easily, and show you that this steam from the marble has the property of remaining in the same place at common temperatures, which *water*-steam has not. If I add a little liquid to the marble and decompose it, I get that which you see—[the Lecturer here put several lumps of marble into a glass jar, and poured water and then acid over them; the carbonic acid immediately commenced to escape with considerable effervescence]—the appearance of boiling, which is only the separation of one part of the marble from another. Now this [marble] steam, and that [water] steam, and all other steams *gravitate* just like any other substance does; they are all attracted the one towards the other, and all fall towards the earth, and what I want you to see is that *this* steam gravitates. I have here (Fig. 2) a large vessel placed upon a balance, and the moment I pour this steam into it you see that the steam gravitates. Just watch the index and see whether it tilts over or not. [The Lecturer here poured the carbonic acid out of the glass in which it was being generated into the vessel suspended on the balance, when the gravitation was at once apparent.] Look how it is going down. How pretty that is! I poured nothing in but the invisible steam, or vapor, or gas which came from the marble, but you see that part of the marble, although it has taken the shape of air, still gravitates as it did before. Now, will it weigh

Fig. 2.



down that bit of paper? [Placing a piece of paper in the opposite scale.] Yes, more than that; it nearly weighs down this bit of paper. [Placing another piece of paper in.] So that you now see that *other* forms of matter besides solids and liquids tend to fall to the earth; and, therefore, you will now accept from me the fact that *all* things gravitate, whatever may be their form or condition. Now *here* is another chemical test which is very rapid. [Some of the carbonic acid was poured from one vessel into another, and its presence in the latter shown by introducing into it a lighted taper, which was immediately extinguished.] You see from this also that it gravitates. All these experiments show you that, tried by the balance, tried by pouring it like water from one vessel to another, this steam, or vapor, or gas, is attracted to the earth just like other things.

Now there is another point that I want to draw your attention to. I have here a quantity of shot; each one of these falls separately, and each has its own gravitating power, as you perceive when I let them fall loosely on a sheet of paper. Now if I put them into a bottle I collect them together as one mass, and philosophers have discovered that there is a certain point in the middle of the whole collection of shots that may be considered as the *one point* in which all their gravitating power is centred, and that point they call the *centre of gravity;* it is not at all a bad name, and rather a short one—the centre of gravity. Now suppose I take a sheet of pasteboard, or any other thing easily dealt with, and suppose I run a bradawl through it at one corner A (Fig. 3), and Mr. Anderson holds that up in his hand before us, and I then take a piece of thread and an ivory ball, and hang that upon the awl, then the centre of gravity of both the pasteboard and the ball and string are as near as they can get to the centre of the earth; that is to say, the whole of the attracting power of the earth is, as it were, centred in a single point of the cardboard; and this point is exactly below the point of suspension. All I have to do, therefore, is to draw a line A B, corresponding with the string, and we shall find that the centre of gravity is somewhere in that line. But where? To find that out all we have to do is to take another place for the awl (Fig. 4), hang the plumb-line, and make the same experiment, and

Fig. 3.

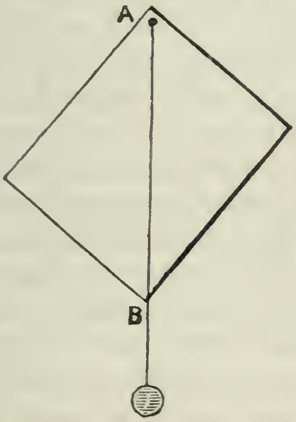
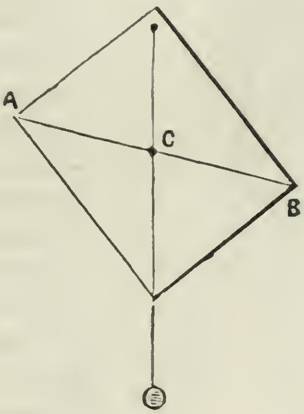


Fig. 4.



there [at the point c] is the centre of gravity—there where the two lines which I have traced cross each other; and if I take that pasteboard, and make a hole with the bradawl through it at that point, you will see that it will be supported in any position in which it may be placed. Now, knowing that, what do I do when I try to stand upon one leg? Do you not see that I push myself over to the left side, and quietly take up the right leg, and thus bring some central point in my body over this left leg? What is that point which I throw over? You will know at once that it is the *centre of gravity*—that point in me in which the whole gravitating force of my body is centred, and which I thus bring in a line over my foot.

Now I have here a toy, which I happened to see the other day, and I think it will serve to illustrate our subject very well. That toy ought to lie something in this manner (Fig. 5). And it would do so if it were uniform in substance; but you see it does not, it will get up again. And now philosophy comes to our aid; and I am perfectly sure, without looking inside the figure, that there is some arrangement there by which the centre of gravity is at the lowest point when the image is standing upright; and we may be certain when I am tilting it over (Fig. 6) that I am lifting up the centre of gravity, and raising it from the earth. All this is effected by putting a piece of lead inside the lower part of the image, and making the base of the large curvature, and there you have the whole secret. But what will happen if I try to make the figure stand upon a sharp point? You observe that I must get that point *exactly* under the centre of gravity or it will fall over thus [endeavoring unsuccessfully to balance it]; and this you see is a difficult matter, I cannot make it stand steadily; but if I embarrass this poor old lady with a world of trouble, and hang this wire with bullets at each end about her neck, you see that it is very evident that owing to there being those two balls of lead hanging down on each side, in addition to the lead inside, I have lowered the centre of gravity, and now she will stand upon this point

Fig. 5.

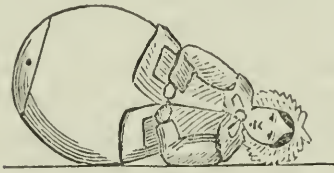


Fig. 6.

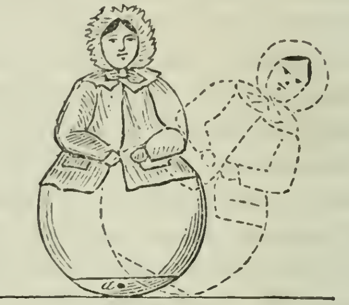
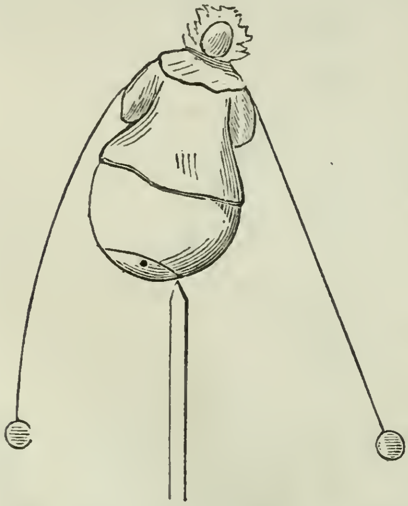


Fig. 7.



(Fig. 7); and, what is more, she proves the truth of our philosophy by standing sideways.

I remember an experiment which puzzled me very much when a boy. I read it in a conjuring book, and this was how the problem was put to us: "How," as the book said, "how to hang a pail of water, by means of a stick, upon the side of a table." Now I have here a table, a piece of stick, and a pail, (Fig. 8,) and the proposition is, how can that pail be hung to the edge of this table? It is to be done, and can you anticipate what arrangement I shall make to enable me to succeed?

Fig. 8.

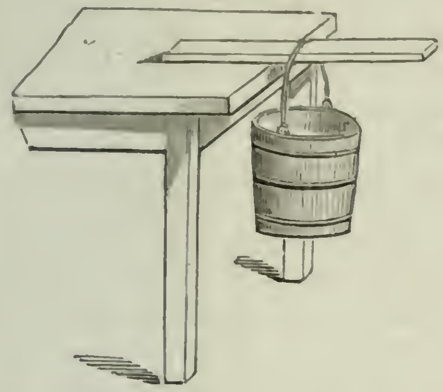
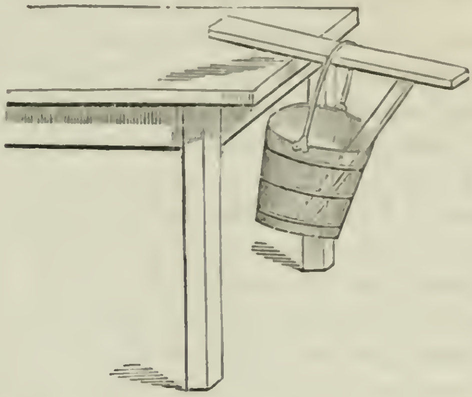


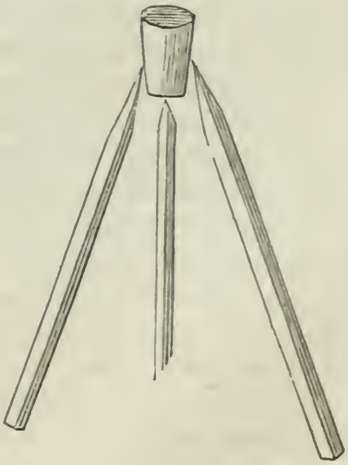
Fig. 9.



Why this. I take a stick, and put it in the pail between the bottom and the horizontal piece of wood, and thus give it a stiff handle, and there it is; and what is more, the more water I put into the pail, the better it will hang. It is very true that before I quite succeeded I had the misfortune to push the bottoms of several pails out; but here it is hanging firmly (Fig. 9), and you now see how you can hang up the pail in the way which the conjuring books require.

Again, if you are really so inclined (and I do hope all of you are), you will find a great deal of philosophy in this [holding up a cork and a pointed thin stick about a foot long]. Do not refer to your toy-books and say you have seen that before. Answer me rather, if I ask you, have you *understood* it before. It is an experiment which used to seem very wonderful to me when I was a boy; I used to take a piece of cork (and I remember I thought at first that it was very important that it should be cut out in the shape of a man, but by degrees I got rid of that idea), and the problem was to balance it on the point of a stick. Why, you see I only have to stick two sharp pointed sticks on each side, and give it wings, thus, and there you will find this beautiful condition fulfilled.

Fig. 10.



I want now to bring you to another point—all bodies, whether heavy or light, fall to the earth by this force which we call gravity. By observation moreover we see that bodies do not occupy the same time in falling: I think you will be able to see that this piece of paper and that ivory ball fall with different velocities to the table [dropping them]; and if again I take a feather and an ivory ball, and let them fall, you see they reach the table or earth at different times; that is to say, the ball falls faster than the feather. Now that should not be so, for all bodies do fall equally fast to the earth. There are one or two beautiful points included in that statement. First of all it is manifest that an ounce, or a pound, or a ton, or a thousand tons, all fall equally fast, no one faster than another; here are two balls of lead, a very light one and a very heavy one, and you perceive they both fall to the earth in the same time. Now if I were to put into a little bag a number of these balls sufficient to make up a bulk equal to the large one, they would also fall in the same time; for if an avalanche falls, the rocks and mountains, snow and ice, together falling towards the earth, fall with the same velocity, whatever be their size.

I cannot take a better illustration of this than that of gold leaf, because it brings before us the reason of this apparent difference in the time of the fall. Here is a piece of gold leaf. Now if I take a lump of gold and this gold leaf, and let them fall through the air together, you see that the lump of gold—the sovereign, or coin—will fall much faster than the gold leaf. But why? They are both gold, whether sovereign or gold leaf. Why should they not fall to the earth with the same quickness? *They would do so*, but the air around our globe interferes very much where we have the piece of gold so extended and enlarged as to offer much obstruction on falling through it. I will, however, show you that gold leaf *does* fall as fast when the resistance of the air is excluded—for if I take a piece of gold leaf and hang it in the centre of a bottle, so that the gold, and the bottle and the air within, shall all have an equal chance of falling, then the gold leaf will fall as fast as anything else. And if I suspend the bottle containing the gold leaf to a string, and set it oscillating like a pendulum, I may make it vibrate as hard as I please, and the gold leaf will not be disturbed, but will swing as steadily as a piece of iron would do; and I might even swing it around my head with any degree of force and it would remain undisturbed. Or, I can try another kind of experiment:—if I raise the gold leaf in this way [pulling the bottle up to the ceiling of the theatre by means of a cord and pulley, and then suddenly letting it fall to within a few inches of the lecture table], and allow it then to fall from the ceiling downwards (I will put something beneath to catch it supposing I should be *maladroit*), you will perceive that the gold leaf is not in the least disturbed. The resistance of the air having been avoided, the glass bottle and gold leaf all fall in exactly the same time.

Here is another illustration:—I have hung a piece of gold leaf in the upper part of this long glass vessel, and I have the means, by a little arrangement at the top, of letting the gold leaf loose. Before we let it loose we will remove the air by means of an air pump, and while that is being done let me show you another experiment of the same kind. Take a penny piece, or a half-crown, and a round piece of paper a trifle smaller in diameter than the coin, and try them side by side to see whether they fall at the same time [dropping them.] You see they do not—the penny piece goes down first. But, now place this paper flat on the top of the coin, so that it shall not meet with any resistance from the air, and upon *then* dropping them you see they *do* both fall in the same time [exhibiting the effect]. I dare say if I were to put this piece of gold leaf, instead of the paper, on the coin it would do as well. It is very difficult to lay the gold leaf so flat that the air shall not get under it and lift it up in falling, and I am very doubtful as to the success of this, because the gold leaf is puckery; but I will risk the experiment. There they go together! [letting them fall,] and you see at once that they both reach the table at the same moment.

We have now the air pumped out of the vessel, and you will perceive that the gold leaf will fall as quickly in this vacuum as the coin does in the air. I am now going to let it loose, and you must be quick to see how rapidly it falls. There! [letting the gold loose,] there it is, falling as gold should fall.

I am sorry to see our time for parting is drawing so near. As I proceed I mean to put upon the board behind me certain words so as to recall to your minds what we have already examined; and I put the word FORCES above all, and I will then add beneath the names of the special forces in the order in which we consider them; and although I fear that I have not sufficiently pointed out to you the more important circumstances connected with this force of GRAVITATION, especially the law which governs its attraction (for which, I think, I must take up a little time at our next meeting), still I will put that word on the board, and I hope you will now remember that we have in some degree considered the *force of gravitation*—that force which causes all bodies to attract each other when they are at sensible distances apart, and tends to draw them together.

*Boiler Explosion on the South Devon Railway.**

At the adjourned inquest the following interesting and valuable evidence was given by Capt. Tyler, the government inspector, who said he had examined the engine and the pieces. She began to run in December, 1853, and having run 62,136 miles was retubed in October, 1854. She had had no material repairs since that date. She was a goods engine, with two safety valves, each four inches in diameter, which he considered to be sufficient. The outer shell of her fire-box consisted of three plates, each 6 ft. by 9 ft. 4½ inches by $\frac{7}{16}$ inches thick, the dome being on the top of the centre plate. On Saturday, the 10th, she was slightly repaired. She weighed 35 tons, and had run 12,232¾ miles since she was retubed. When she exploded, three portions of the outer shell of the fire-box flew off, besides some smaller pieces, one of these 4 feet by 13½ inches blew to the left through the side of the shed; a second 4 feet 6 inches by 3 feet six inches fell in the permanent way about 15 feet to the right of the engine, and the third 4 feet 3 inches by 2 feet blew against a wall a distance of 30 yards. A whistle was picked up 330 yards, and a lever 230 yards from the engine. The portion of the boiler which flew to the left wa divided from the other portions just above the line of the seam of rivets and, therefore, he particularly examined this seam. He found th rivets still in their places. The plate was originally $\frac{7}{16}$ of an inch, bu was eaten through in a line regularly from $\frac{3}{16}$ to $\frac{5}{16}$ of an inch, leavin only a very small portion of the metal still holding before the explosion. There was a similar seam on the right of the fire-box whic appeared likely to have been eaten away in a similar manner to th portion which had given way on the left. Mr. Wright had this sea broken apart, and he now produced it so that it would afford the jury better idea of his meaning. This effect had been produced upon the boiler by various causes. In the first place the boiler had evidently been injured during its construction by the application of the caulking tool i caulking the edge of the plate; the surface of all the plates of the boile that he had been able to see had been more or less injured. He explained that the caulker, which is a kind of cutter, had in the use of i made a kind of cut, and this wound being produced corrosion had take place. The corroded surface was interfered with by the mechanica working of the boiler, arising from internal pressure, as well as the expansion and contraction due to differences of temperature, and thi effect was increased when bad water was used. He found that the Company had great difficulty in getting good water at Newton, up to November, 1858, and the salt water taken from the river was used wit this engine twice a-day up to that date. It was partly on this account no doubt, that the corrosive action to which he had referred had proceeded to so great an extent on so young an engine. There wer no means of examining the interior of the fire-box, to detect a fla of this description, without taking the boiler to pieces or drillin holes in it. There were certain precautions which might be adopte to prevent such accidents for the future. First, by taking additiona care to see that the caulking was performed without injury to th boiler; secondly, by the use of good water; thirdly, by the use o additional stays, which would tend to prevent the explosion as wel as check the mechanical action referred to; and, fourthly, by testin the boiler periodically by hydraulic pressure, up to, say 50 per cent beyond the ordinary working pressure of the engine. The valves o this engine were set to a working pressure of 120 lbs. to the squar inch, when the explosion took place. Capt. Tyler stated, in addition but it was not taken as evidence, that a curious fact had occurre since the accident. An engine at Newton was discovered to be in similarly defective state from the same causes, but, in consequence o its being stayed more effectually, it had resolved itself into a leak.

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* From Herapath's Railway Journal, No. 1086.

The Coroner having briefly summed up,

The Jury found a verdict—"That the deceased had been killed by the accidental bursting of the engine boiler." The Jury expressed their satisfaction at the lucid report of Capt. Tyler, and hoped every publicity would be given it with a view to prevent the recurrence o such an accident in the future. They also thanked Capt. Tyler and the officers of the Railway Company for the facilities they had afforded them.

*On the Manufacture of the Carbon Elements for Bunsen Batteries.**

By John Young, Manager of the Gas Works, Dalkeith.

The advantages attending the use of the Bunsen Battery as a powerful source of electric action has led to its very general adoption, especially in those experiments of a more brilliant character. The peculiar construction of this battery consists in substituting for platinum, carbon of that condition found in the interior of gas retorts. The difficulty of procuring carbon of this sort, and especially of giving it a proper form when obtained, led to the series of experiments and their results which form the subject of this communication.

Hitherto the supply of prepared carbons has almost exclusively been furnished to this country from the Continent; and so far as they have come under my observation they were made from the retort carbon above mentioned. The precariousness of a supply from this source, and the fact of its being dependent for its continuance upon an evil which gas engineers are trying all means to overcome, suggested the propriety of finding some compound, and mode of treating it, which would render us equally independent of foreign aid, and that period in the history of gas-lighting when the engineer has attained his object. During the spring of last year these experiments were entered upon; and for several weeks at first occupied my whole attention, and at brief intervals during the summer were resumed. In the first outset we were entirely guided in our procedure by the information of the composition and treatment of the carbons by Professor Bunsen, as given in several works on electrical science; but whether the material used by me or the mode of treatment differed from that of the Professor we do not know, but the results in our hands were most unsatisfactory indeed. The prescribed composition used by the Professor is "coke and coal in fine powder, heated together in an iron mould, thus forming a mass of solid carbon of the required form. To give greater solidity, they were plunged into a syrup of sugar, afterwards dried, and then submitted to an intense heat in covered vessels." These instructions are apparently plain enough, unencumbered by detail, and would indicate, by their brevity, that the *solid mass of carbon* was so sure of being obtained that more minute instructions were totally unnecessary. In our experiments we employed the finest pieces of Newcastle coke in powder and the finest English caking coal, and followed the recipe with great care. We used (1) cold moulds, afterwards heating them carefully; and (2) red-hot moulds, and packed in the composition in a fused state; and yet the four weeks in which we were so occupied were characterized by one series of failures, during which we had wasted large quantities of sugar, besides less valuable materials, without receiving a single hint that we were proceeding in the right direction; and not until a partially new process was entered upon did hopes arise that we would ever attain our object. The carbon elements so obtained were either loose and friable, or altogether in a state of powder, or so full of cracks and fissures, when an excess of coal was used, that in either case they were useless. Some of the best we endeavored to finish; but after repeated soakings in the syrup of sugar, we could with difficulty produce them of sufficient density; and, when attainable, only at such expense as precluded competition in price with those already in the market.

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* From the Lond. Chemical News, No. 12.

Starting anew, and availing ourselves of the varieties of coke within reach, and trusting to our own observations for guidance, we entered upon a new series of experiments with different kinds of coke, mixed in various proportions, and differently treated. Among failures, we also had hints of success, and from noting the changes by which these favorable hints had been furnished, we were able to proceed under more cheering prospects. The results of these experiments were, that the coke from the Marquis of Lothian's parrot coal, as left in the gas retort, was best. What peculiarity in this coke should make it superior we cannot say, unless it be the small amount of ash that it contains; but when used by us, it was always covered by a peculiar glistening, silvery deposit of carbon from its own gas. The amount of ash in the coke we found to be less than 7 per cent.

After many trials, we obtained the best results from the following mixture and mode of treatment—viz: 64 per cent. by weight of coke powder, and 36 per cent. of English caking coal in powder, well mixed, and moistened with a solution of sugar or starch, until the mass, when pressed in the hand, retained its form. When starch was used, it was in the form of mucilage; and when syrup of sugar was used, it was composed of one part of sugar to one and a half of water. The prepared composition was pressed very hard into moulds of the required form, and when taken from the mould the cakes were set aside to dry. The use of sugar or starch in the composition is to cause the adhesion of the particles of coke and coal powder, so that they retain the form of the mould, and when dry become a hard cake that can be handled, and closely packed into the coking-mould. The part of the process referred to is conducted precisely the same as in the manufacture of ordinary bricks; but the similarity of manufacture goes no further, as all air has to be excluded from the carbons, otherwise combustion ensues, and entirely destroys them. To prevent the action of the air, the coking is done inside a gas retort, into which a small quantity of coal had been introduced to expel the air. The box or mould in which the bricks were packed during the coking contained thirteen carbons at one time. The length of the box was equal to the thickness of the whole thirteen, including plates of iron of ⅛-inch thickness, which were placed between them, to prevent the carbons from fusing together.—The breadth of the box was equal to the length of the carbons, and the depth equal to the breadth of the carbons. The mould with cover was so constructed, that the encased carbons should be closely clamped up and compressed between the plates while coking. The great tendency that the caking coal has to tumify while in fusion, by the escape of the gas, made this precaution the more necessary; and unless attended to the carbons would have been loose and porous. The box and its contents were in the retort for about one hour and a half, at a bright cherry-red heat; and when taken out were covered over with dry dust until cold, to prevent the air from acting on the carbons through the chinks round the cover. When taken from the box the carbons have a close surface, owing to the iron plates compressing the exuding fused coke. At this stage they have no electrical action, and are entirely dependent upon the subsequent parts of the process for the deposit of carbon to bestow this property. From this point in the manufacture, my mode of treatment is new, and depends for the closing of the pores in the coke to the fixed carbon from a soaking of coal tar, and the carbonaceous deposit from gas during its liberation from the coal. My experiments upon sugar, as a source of cementing carbon, showed me that at the best it would be expensive, and exceedingly slow in its action, from the low per centage of fixed carbon that it left. When the syrup used was composed of equal weights of sugar and water, the fixed carbon was only 13 per cent. of the liquid absorbed, or 26 per cent. of the sugar in the solution. At this rate, every ounce weight added to the carbons would cost 1¼*d.* with sugar at its present cheap rate, besides the additional trouble of having the carbons to dry after each soaking. In using coal tar as a substitute, we first heated it to a temperature of 300°, so as to drive off the naphtha hydro-carbons, which left it in a semi-pitched condition; and while still hot the coke bars were soaked in it till saturated, and sank to the bottom. The per centage of fixed carbon left in the coke after the soaking, and heated to redness, was 32·5 per cent. of the tar absorbed, or 2½ times the weight obtained from sugar, and secured at an infinitely less cost. Pure tar carbon is among the best that I have yet tried for Bunsen Batteries, and it was the success in some experiments that I was making with it that induced me to try it as a source of fixed carbon for the purpose now mentioned.

Three separate soakings in the tar, as described, and as many times heated to a high temperature, are necessary fully to close the pores of the coke. Before the last steeping, the carbons are ground upon a flat stone into the required shape. In grinding, a little water is used, but only so much as may form the abraded powder from the carbons into a pasty state; and as the carbons are still absorbent at this stage, they imbibe the water from the paste, and leave the particles of carbon deposited in the pores on the surface, thereby leaving the close surface shown in the finished state. The carbons are again soaked in tar, and charred at a high temperature, when the process is completed by the final smoothing on a flat stone.

The manufacture of the carbons is conducted simultaneously with the process of gas-making; and thereby, with economy of heat, a considerable amount of carbon is deposited from the gas itself, in addition to the fixed carbon from the tar absorbed. For convenience of having them properly placed upon the coal in the retort, a long semicircular trough of iron is prepared (similar to a water run for eaves of houses) to contain from twelve to twenty at one time, and after the charge of coal is introduced, and before closed up, the long trough and its contents are thrust in over the coals, close up to the roof of the retort, and allowed to remain till the charge of coal is wrought off—a period of nearly three and a half hours. On being withdrawn, the carbons are scattered about, to cool as rapidly as possible, and prevent their burning away by the action of the air; and when cold they receive the slight rub to smooth them, which finishes the process.

I do not wish it to be understood that I consider these carbon elements have reached their perfect state. This notice only shows the process in a comparatively infant stage; and I hope to be able to prosecute the experiments to greater maturity, so as to be able to place a still better article in the hands of the student of electricity.—*Transactions of the Royal Scottish Society of Arts.*

*Experiments on the Total Heat of Steam.** By J. P. Joule, LL.D., F.R.S.—[Read before the Philosophical Society of Manchester.]

The author showed that what is called the total heat of steam, or the quantity liberated when steam is condensed into water of 0° centigrade, consists of—1st, the true heat of evaporation; 2d, the heat due to the work done on the steam during the condensation; and 3d, the heat liberated by cooling the water from the temperature of condensation to the freezing point. The determination of the total heat of steam had been made the object of a very careful and elaborate research by Regnault; but it appeared to the author that independent experiments, conducted in a different and more direct manner, would not be without interest. The following is a summary of the results obtained by him, compared with those of Regnault:

Total pressure of Steam in Inches.	Total Heat in Degrees Centigrade.	
	Author.	Regnault.
37·25	638·43	638·77
57·52	644·77	642·87
111·58	655·45	649·06

On the Conductibility of certain Alloys for Heat and Electricity.†

By G. Wiedemann.

In an experimental investigation, Wiedemann and Franz‡ found that the thermal and electrical conductibility of metals was nearly identical. Their researches also showed that in brass (which contains 1 part of zinc to 2 of copper) the thermal conductibility differs but very little from that of the worse conducting metal, zinc, although the latter is present in smallest quantity. In other alloys, as those of tin and lead, an analogous relation prevails in reference to the electric conductibility. Messrs. Calvert and Johnson have lately investigated the thermal conductibility of several alloys, and have arrived at results which differ materially from those of Wiedemann and Franz, and which render doubtful the analogy which had been established between the thermal and electrical conductibility. Wiedemann has accordingly determined the conductibility for heat and electricity of several alloys. He used the same method as in the previous researches, and the following Table contains the results at which he has arrived. The standard adopted is silver, the conductibility of which, both for heat and electricity, is taken at 100. Copper zinc $\frac{8}{1}$ denotes an alloy containing 8 parts of copper to one of zinc.

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* From Newton's London Journal, April, 1860.

† From the Lond., Edin., and Dub. Philosophical Mag., March, 1860.

‡ Phil. Mag. [4] vol. vii. p. 33; vol. x. p. 393.

	Conductibility for	
	Heat.	Electricity.
Copper,	73·6	79·3
Copper-Zinc $\frac{8}{1}$,	27·3	25·5
Copper-Zinc $\frac{6\cdot5}{1}$,	29·9	30·9
Copper-Zinc $\frac{4\cdot7}{1}$,	31·1	29·2
Brass $\frac{2\cdot1}{1}$,	25·8	25·4
Zinc,	28·1	27·3
Tin,	15·2	17·0
Tin-Bismuth $\frac{3}{}$,	10·1	9·0
Tin-Bismuth $\frac{1}{1}$,	5·6	4·4
Tin-Bismuth $\frac{1}{3}$,	2·3	2·0
Rose's Metal,	4·0	3·2

From these results Wiedemann concludes—

1. That the agreement, which had been previously found to exist, between the thermal and electrical conductibility of metals obtains also for alloys.

2. That the conductibilities of alloys of zinc and copper, for heat as well as for electricity, differ but little, even with a considerable excess of copper, from the conductibility of the worse conducting metal, zinc. The alloys of zinc and bismuth, on the contrary, have nearly the mean conductibility calculated from their atomic composition.—Poggendorff's *Annalen*, Nov., 1859.

*On a Method of Testing the Strength of Steam Boilers.**

By Dr. JOULE.

The author adverted to the means hitherto adopted for testing boilers. 1st. That by steam pressure, which gives no certain indication whether strain has not taken place under its influence, so that a boiler so tested may subsequently explode when worked at the same or even a somewhat less degree of pressure. He trusted that this highly reprehensible practice had been wholly abandoned. 2d, That by hydraulic pressure obtained by a force pump, which does not afford an absolutely reliable proof that the boiler has passed the ordeal without injury, and moreover requires a special apparatus. The plan which had been adopted by the author for two years past, with perfect success, was free from the objections which applied to the above, and is as follows: The boiler is entirely filled with water; then a brisk fire is made in or under it. When the water has thereby been warmed a little, say to 70° or 90° Fahrenheit, the safety valve is loaded to the pressure up to which the boiler is to be tested. Bourdon's or other pressure indicator is then constantly observed; and if the pressure occasioned by the expansion of the water increases continuously up to the testing pressure, without sudden stoppage or diminution, it may be safely inferred that the boiler has stood it without strain or incipient rupture.

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* From Newton's London Journal, April, 1860.

In the trials made by the author, the pressure rose from zero to 62 lbs. on the square inch in five minutes. The facility of proving a boiler by this method was so great, that he trusted that owners would be induced to make those periodical tests, without which, fatal experience had shown that no boiler should be trusted.

On Tungsten Steel.[*] By F. X. Wurm.

Franz Mayr has produced, at his cast steel works at Kapfenberg, in Styria, cast steel of such dimensions, forms, and excellent quality, as could previously only be obtained from Krupp, of Essen. Oblique cog-wheels for coining machines and locomotives, axles for railway carriages, boiler plates, angle knees, and round, flat, and quadrangular rods, of various sections, have now been produced by Mayr for more than a year.

What particularly deserves to be mentioned with regard to these articles, is Mayr's unrivalled tungsten-steel distinguished by the fineness of its crystalline texture and its remarkable hardness, so much so, indeed, that the experiments made with it several months ago have shown that tools made from it for cutting toothed wheels, borers, chisels, punches, turning tools, planing blades, &c., retain their power of cutting four times as long as those made of Hundsman-steel, previously regarded as the best. This steel may therefore be recommended as the best for these purposes.

Tungsten has nearly the same specific gravity as gold, and this density is recognisable in the cast steel alloyed with it, by the alteration in the grain of the fractured surface, and by the heightened ring of the steel.

In hardness, metallic tungsten nearly approaches the hardest of natural bodies, and it communicates this property to cast steel, without injuring its tenacity and malleability when the addition is of 2 – 5 per cent.

The absolute solidity of tungsten-steel exceeds that of all other known steels, for fifteen consecutive experiments with a machine in the Polytechnic Institute of Vienna showed the highest power of resistance to be 1393 hundredweights, and the lowest 1015 hundredweights, giving an average of $1158\frac{13}{15}$ hundredweights to the square inch; so that this steel exceeds all other kinds hitherto tried.

The ore of tungsten from which the metal is obtained, usually occurs

[*] From the London Chemical Gazette, No. 403.

in company with tin-stone; it has probably hitherto never obtained any technical application, as it has only been regarded as a mineralogical curiosity.

More recent investigations have shown, however, that the arts may derive considerable benefit from it. One of the richest sources of this ore is possessed by the Austrian empire in the tin mines of Zinnwald in Bohemia, where the tungsten ore has been thrown upon the heaps as worthless for nearly five hundred years.

Mayr has the great merit of having been the first to bring this new and hitherto unemployed metal into use in the manufacture of cast steel on the large scale, having introduced tungstic cast steel into commerce of the most various degrees of hardness, and of any dimensions.

The price of this steel, notwithstanding its remarkable goodness, is lower than that of the English cast steel, over which the uniformity of its crystalline texture gives it a peculiar advantage.

The above properties of density, hardness, and strength, are also communicated by tungsten to cast iron, and this alloy may probably be useful for crushing-rollers, and may perhaps in time attract the attention of the artillery.—Dingler's *Polyt. Journal*, clii, p. 178.

For the Journal of the Franklin Institute.

Particulars of the Steamer Flushing.

Hull built by Samuel Sneden & Co. Machinery by Morgan Iron Works, New York. Designed by T. F. Rowland, Engineer. Owners, New York and College Point and Flushing Steamboat Company. Intended service, New York to Flushing.

Hull.—Length on deck, 161 ft. Do. at load line, 155 ft. Breadth of beam (molded), 27 ft. Depth of hold to spar deck, 8 ft. Frame, L; depth, 3 ins.; width of web, 5-16 in.; width of flanches, 3 ins. Plates, thickness, 5-16 to No. 3. Cross Floors, 12 ins. deep $\times \frac{1}{4}$-in., connecting every alternate frame. Keel, depth, 3 ins. Rivets, $\frac{5}{8}$-in. diameter; apart, $2\frac{1}{8}$ ins. Bulkheads, 3. Draft when launched, 2 ft. 2 ins. Do. when loaded, 4 ft. Tonnage, 323. Area of immersed section at load draft of 4 ft , 85 sq. ft.

Engines.—Vertical beam. Diameter of cylinder, 36 ins. Length of stroke, 10 ft. Maximum pressure of steam, 50 lbs. Cut-off, 5 ft. Maximum revolutions at above pressure, 27.

Boiler.—One—Return tubular. Length of boiler, 24 ft. Breadth do., furnace, 10 ft., shell, 8 ft. 6 ins. Number of furnaces, two. Breadth do., 4 ft. 6 ins. Length of grate bars, 7 ft. Number of tubes, above, 140. Do. flues, below, 10. Internal diameter of tubes, above, $2\frac{3}{4}$ ins. Do. flues, below, 6 of 12 ins., 2 of 9 ins., and 2 of 13 ins. Length of tubes, above, 10 ft. Heating surface, 2200 sq. ft. Diameter of smoke-pipes, 3 ft. 6 ins. Height do., 50 ft.

Paddle Wheels.—Diameter over boards, 26 ft. Length of blades, 6 ft. 6 ins. Number of do., 22.

Remarks.—Two box keelsons and four plate keelsons running fore and aft. Iron in hull, 136,000 lbs.

Trial in May, 1859. C. H. H.

For the Journal of the Franklin Institute.

Particulars of the Stern-wheel Steamer Vencedor.

Hull built by Samuel Sneden & Co. Machinery by H. Ester & Co., New York. Designed by T. F. Rowland, engineer. Owners, Magdalena Steam Navigation Co. Intended service, Magdalena River.

Hull.—Length on deck, 155 ft. Do. at load line, 150 ft. Breadth of beam (molded), 24 ft. Depth of hold to spar deck, 5 ft. Frame—molded, 6 ins.—sided, 4 ins.—apart from centres, 24 ins. Bulkheads, two. Bottom plank, 2 ft. 5 ins. thick, of yellow pine. Sides, 2 ins. thick, do. do. Decks, white pine, 2 ins. thick. Promenade deck, do., 1 in. thick. Hurricane do., do., ¾-in. do. Draft, forward and aft, loaded, 3 ft. 6 ins. Area of immersed section at load draft of 3 ft. 5 ins., 82 sq. ft.

Engines.—Inclined direct. Diameter of cylinder, 16 ins. Length of stroke, 6 ft. Maximum pressure of steam, 120 lbs. Cut-off, variable. Maximum revolutions at above pressure, 35.

Boiler.—One—Locomotive. Length of boiler, 18 ft. 8 ins. Breadth do., 8 ft. 1 in. Height do. exclusive of steam chimney, 7 ft. 6 ins. Number of furnaces, 2. Breadth do., 3 ft. 6 ins. Length of grate bars, 6 ft. Number of tubes, 138. Internal diameter of do., 3 ins. Length of do., 12 ft. Heating surface, 1500 sq. ft. Diameter of smoke-pipes, 3 ft.

Paddle Wheels.—Diameter over boards, 16 ft. Length of blades, 17 ft. Depth of do., 15 ins. Number of do., 15.

C. H. H.

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*On Light-house Illumination.—The Electric Light.** By Prof. FARADAY, D. C. L., F. R. S.

[Royal Institution of Great Britain.]

The use of light to guide the mariner as he approaches land, or passes through intricate channels, has, with the advance of society and its ever increasing interests, 'caused such a necessity for means more and more perfect, as to tax to the utmost the powers both of the philosopher and the practical man, in the development of the principles concerned and their efficient application. Formerly the means were simple enough; and if the light of a lantern or torch was not sufficient to point out a position, a fire had to be made in their place. As the system became developed, it soon appeared that power could be obtained, not merely by increasing the light, but by directing the issuing rays; and this was in many cases a more powerful and useful means than enlarging the combustion; leading to the diminution of the volume of the former with, at the same time, an increase in its intensity. Direction was obtained, either by the use of lenses dependent altogether upon refraction, or of reflectors dependent upon metallic reflection. [And some ancient specimens of both were shown.] In modern times the principle of total reflection has also been employed, which involves the use of glass, and depends both upon refraction and reflection. In all these appliances much light is lost; if metal be used for reflection, a certain proportion is absorbed by the face of the metal; if glass be used for refraction, light is lost at all the surfaces where the ray passes between the air and the glass; and also in some degree by absorption in the body of the glass itself. There is, of course, no power of actually increasing the whole amount of light, by any optical arrangement associated with it.

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* From the Lond. Ed. and Dub. Phil. Mag., April, 1860.

The light which issues forth into space must have a certain amount of divergence. The divergence in the vertical direction must be enough to cover the sea from the horizon, to within a certain moderate distance from the shore, so that all ships within that distance may have a view of their luminous guide. If it have less, it may escape observation where it ought to be seen; if it have more, light is thrown away which ought to be directed within the useful degree of divergence; or, if the horizontal divergence be considered, it may be necessary so to construct the optical apparatus, that the light within an angle of 60° or 45° shall be compressed into a beam diverging only 15°, that it may give in the distance a bright flash having a certain duration instead of a continuous light,—or into one diverging only 5° or 6°, which, though of far shorter duration, has greatly increased intensity and penetrating power in hazy weather. The amount of divergence depends in a large degree upon the bulk of the source of light, and cannot be made less than a certain amount, with a flame of a given size. If the flame of an Argand lamp, $\frac{7}{8}$ of an inch wide and $1\frac{1}{2}$ inch high, be placed in the focus of an ordinary Trinity House parabolic reflector, it will supply a beam having about 15° divergence; if we wish to increase the effect of brightness, we cannot properly do it by enlarging the lamp flame; for though lamps are made for the dioptric arrangement of Fresnel, which have as many as four wicks, flames $3\frac{1}{2}$ inches wide, and burn like intense furnaces, yet if one be put into the lamp place of the reflector referred to, its effect would chiefly be to give a beam of wider divergence; and if to correct this, the reflector were made with a greater focal distance, then it must be altogether of a much larger size. The same general result occurs with the dioptric apparatus; and here, where the four-wicked lamps are used, they are placed at times nearly 40 inches distant from the lens, occasioning the necessity of a very large, though very fine, glass apparatus.

On the other hand, if the light could be compressed, the necessity for such large apparatus would cease, and it might be reduced from the size of a room to the size of a hat; and here it is that we seek in the electric spark, and such like concentrated sources of light, for aid in illumination. It is very true, that by adding lamp to lamp, each with its reflector, upon one face or direction, power can be gained; and in some of the revolving lights, ten lamps and reflectors unite to give the required flash. But then not more than three of these faces can be placed in the whole circle; and if a fixed light be required in all directions round the light-house, nothing better has been yet established than the four-wicked Fresnel lamp in the centre of its dioptric and catadioptric apparatus. Now the electric light can be raised up easily to an equality with the oil lamp, and if then substituted for the latter, will give all the effect of the latter; or by expenditure of money it can be raised to a five or tenfold power, or more, and will then give five or tenfold effect. This can be done, not merely without increase of the volume of the light, but whilst the light shall have a volume scarcely the 2000th part of that of the oil flame. Hence the extraordinary assistance we may expect to obtain by diminishing the size, and perfecting the optical part of the apparatus.

Many compressed intense lights have been submitted to the Trinity House; and that corporation has shown its great desire to advance all such objects and improve the lighting of the coast, by spending, upon various occasions, much money and much time for this end. It is manifest that the use of a light-house must be never failing, its service ever sure; and that the latter cannot be interfered with by the introduction of any plan, or proposition, or apparatus, which has not been developed to the fullest possible extent, as to the amount of light produced,—the expense of such a light,—the wear and tear of the apparatus employed,—the steadiness of the light for 16 hours,—its liability to extinction,—the amount of necessary night care,—the number of attendants,—the nature of probable accidents,—its fitness for secluded places, and other contingent circumstances, which can as well be ascertained out of a light-house as in it. The electric spark which has been placed in the South Foreland, High Light, by Prof. Holmes, to do duty for the six winter months, had to go through all this preparatory education before it could be allowed this practical trial. It is not obtained from frictional electricity, or from voltaic electricity, but from magnetic action. The first spark (and even magnetic electricity as a whole) was obtained twenty-eight years ago. (Faraday, Philosophical Transactions, 1832, p. 32.) If an iron core be surrounded by wire, and then moved in the right direction near the poles of a magnet, a current of electricity passes, or tends to pass, through it. Many powerful magnets are therefore arranged on a wheel, that they may be associated very near to another wheel, on which are fixed many helices with their cores like that described. Again, a third wheel consists of magnets arranged like the first; next to this is another wheel of the helices, and next to this again a fifth wheel carrying magnets. All the magnet-wheels are fixed to one axle, and all the helix wheels are held immovable in their place. The wires of the helices are conjoined and connected with a commutator, which, as the magnet-wheels are moved round, gathers the various electric currents produced in the helices, and sends them up through two insulated wires in one common stream of electricity into the light-house lantern. So it will be seen that nothing more is required to produce the electricity than to revolve the magnet-wheels. There are two magneto-electric machines at the South Foreland, each being put in motion by a two horse power steam engine; and, excepting wear and tear, the whole consumption of material to produce the light is the coke and water required to raise steam for the engines and carbon points for the lamp in the lantern.

The lamp is a delicate arrangement of machinery, holding the two carbons between which the electric light exists, and regulating their adjustment; so that whilst they gradually consume away, the place of the light shall not be altered. The electric wires end in the two bars of a small railway; and upon these the lamp stands. When the carbons of a lamp are nearly gone, the lamp is lifted off and another nstantly pushed into its place. The machines and lamp have done their duty during the past six months in a real and practical manner. The light has never gone out through any deficiency or cause in the engine and machine house; and when it has become extinguished in the lantern, a single touch of the keeper's hand has set it shining as bright as ever. The light shone up and down the Channel, and across nto France, with a power far surpassing that of any other fixed light within sight, or anywhere existent. The experiment has been a good one. There is still the matter of expense and some other circumstances to be considered; but it is the hope and desire of the Trinity House, and all interested in the subject, that it should ultimately justify its full adoption.

For the Journal of the Franklin Institute.

Particulars of the Steamer Daniel Drew.

Hull built by Thomas Colyer. Machinery by Neptune Iron Works, New York. Owners, Daniel Drew and others.

Hull.—Length on deck, 251 ft. 8 ins. Do. at load line, 244 ft. Breadth of beam (molded), 30 ft. 6 ins. Depth of hold to spar deck, 9 ft. 3 ins. Frames—molded, 15¾ ins.—sided, 4 ins.—apart from centres, 30 ins. Keel, depth, 3 ins. Draft, forward and aft, 4 ft. 6 ins.

Engine.—Vertical beam. Diameter of cylinder, 60 ins. Length of stroke, 10 ft. Maximum pressure of steam, 35 lbs. Cut-off, one-half. Maximum revolutions at above pressure, 26.

Boilers.—Two—Return flued. Length of boilers, 29 ft. Breadth do., at furnace, 9 ft., at shell, 8 ft. Height do., exclusive of steam chimney, 9 ft. 4 ins. Number of furnaces, two. Length of grate bars, 7 ft. Number of flues, above, 14; below, 10. Internal diameter of do., above, 9¼ ins. Do. do., below, 2 of 13½ ins., 1 each of 13, 11, and 7¼ ins. Length of do., above, 22 ft. Heating surface, 3350 sq. ft. Diameter of smoke-pipes, 4 ft. Height do., 32 ft.

Paddle Wheels.—Diameter over boards, 29 ft. Length of blades, 9 ft. Depth of do., 26 ins. Number of do., 24.

Remarks.—One independent steam, fire, and bilge pump.

This steamer has been built to attain a very high speed, having a very easy and a very superior model. The velocity of the periphery of her water-wheel blades is 27 miles an hour.

Date of trial, May, 1860. C. H. H

British Modular Standard of Length.[*] By J. F. W. Herschel.

It may not be unwelcome to the scientific portion of your readers to have their attention directed to a simple numerical relation between our actual parliamentary standard of length and the dimensions of the earth, which, in effect, puts us in easy possession of a "modular" system, which might be decimalized, and which, abstractedly considered,

[*] From the Lond. Athenæum, April, 1860.

is far more scientific in its origin, and, numerically, very far more accurate than the boasted metrical system of our French neighbors. I is simply this,—if the British Imperial standard inch were increased by one-thousandth part it would be, with all but mathematical precision one five-hundred-millionth part of the earth's axis of rotation.

The calculations of the present Astronomer Royal, published in the year 1830, have determined the length of this axis at 41,707,620 feet that is to say, 500,491,440 inches of our Imperial standard. Those of Bessel, published in 1841, at 500,487,744 such inches. More recently an elaborate *résumé* of the whole subject, by M. Schubert, has conducted him to three separate and independent conclusions, based on arcs measured each in, or near, a meridian appropriate to the country in which they have been performed, viz: the Russian, the British Indian, and the French arcs. The Russian and the Indian combinations give respectively 500,532,120 and 500,550,168, while the French arc gives only 500,368,920. M. Schubert rejects the latter altogether; but the propriety of doing so appears to Mr. Airy questionable on grounds which we consider so far reasonable as to entitle it to at least half the weight of either of the former. On the other hand, M. Schubert, in computing his mean result, assigns to the Russian result double the weight of the Indian,—a decision in which I can by no means acquiesce. Allowing to each of the former the weight 2, and to the latter 1, the final conclusion from this calculation is 500,506,699 ; and from the mean of Airy, Bessel, and Schubert, 500,495,294, which differs from 500,500,000 by *less than its hundred-and-six-thousandth part.* This then is the fractional error of our "modular" unit in proportion to its own length of 1·001 British standard inch, or that of a "module" of 50·05 such inches, which, in this view of the subject, might be taken for the British unit of linear measure, or one ten-millionth of the earth's axis. The Astronomer Royal, in discussing these computations of M. Schubert (vol. xx, *Notices of the Royal Astron. Soc.* p. 105), insists, very properly, on the individuality of the polar diameter of the earth as compared with its equatorial diameters, which differ materially in different meridians (having regard to an imaginary sea-level, and independently of the heights of mountains or continents). If any axis be chosen for a scientific unit it should assuredly be the polar axis. The nature of things gives this an absolute, indefeasible preference to every other, not excepting even that of the equator in the meridian of Paris itself.

Every geometer will agree that the radius of a circle is a more fundamental or primary parameter, or unit of linear dimensions, than its circumference. To beings of other psychological constitution than man, it may be otherwise; but take the genus *homo* and the species *geometer* as they stand, this is a fact. *A fortiori*, the axis, major or minor, of an ellipse is a more primary and fundamental unit of its dimensions than its periphery, leaving the question as to *which* axis, major or minor, to be decided on its own grounds.

The French métre is assumed to be the ten-millionth part of the quadrant of the earth's elliptic meridian passing through Paris. Its alue is authoritatively stated in the Annuary of the French Board of ongitude at 39·37079 British Imperial standard inches; and, there-ore, in reference to the natural unit in which it originates, is erroneous y one part in 8400 of its proper length, that is to say, between 12 nd 13 times more in proportion than our proposed module.

The adoption of such a "British Modular System" of measure re-uires no Act of Parliament. It is so easy to convert "Imperial stand-rd" lengths, of whatever denomination, into "British modular" engths of the same denomination by subtracting (or modular into im-erial by adding) one-thousandth, that it is not worth while to legis-ate on the subject, so far as measures of length are concerned. The ifference between one part in 1000 and one in 999, in the conversion nd re-conversion, being only one in 999,000, is of no importance what-ver. Nor is it worth while to change our ordinary parlance. 1 foot r 1 yard, in 1000, is a difference telling as nothing in any practical ontract for work on a great scale. On a small one it is quite inap-reciable. The scientific man only is interested in it; and it suffices im to know (and the knowledge, to him, is important) that he can efer all his measurements to the best unit nature affords, by subtract-ng a thousandth (that is, by writing his figures twice over, in two ines, one under the other, shifting the lower three figures to the right, nd executing a subtraction sum) far better than by referring to the *nnuaires des Bureaux* of metricized countries, and performing a alculation of greater complexity, landing him in twelve or thirteen imes the amount of error. Of course, I am not speaking of a system f *decimalization*. To decimalize our measures we must reduce them o "modular inches," or to "modules" of 50 such inches; but we may peak of modular miles, yards, feet, or inches with reference to a modu-ar unit, while retaining the associations of our actual metrical sys-em. A similar remark applies to the Russian metrical system, which s based upon the English—the fundamental unit being the *Sagene* of British feet.

I ought, in fairness, to mention that my attention was drawn in the irst instance to this *rapprochement* by the statement, over and over gain repeated in Mr. Taylor's recent work, entitled "The Great yramid, Why was it Built? &c." (Longman, 1859) (pp. 35, 36, 67, 7, 280, 298, &c.,) that the diameter of the earth in the latitude of the yramid is 41,666,667 English feet, or 500,000,000 of English inches; hich it is not: and it is singular that the reduction of Mr. Airy's olar axis from feet to inches, in page 87, which is rightly performed, oes not appear to have suggested the least misgiving as to the cor-ectness of the statement, or (which is more to our present purpose) ed him to notice the important practical facility of reduction from the arliamentary to the modular standard above insisted on. It is not ny object here to criticize the work in question, which, in the midst f much confusion and no small amount of error, contains some valuable nd (so far as we are aware) original remarks. Of these I may men-ion the conclusion its author has drawn from the angle of slope of the asing-stones discovered by Col. Vyse, that the builders of the Pyramid were acquainted with the ratio of the circumference of a circle to its diameter—a piece of knowledge they were desirous to embody in its dimensions. In fact, the slope of the original faces of the Pyramid comes out from Vyse's (or Perring's) measurement of the linear dimensions of these stones, 51° 52′ 15½″, and by Brettel's measure of their angle, 51° 50′ 0″, the mean of which differs *only by a single second* from the angle whose cotangent is the length of an arc of 45° of the circle, so as to make the whole periphery of the base all but mathematically equal to the circumference of a circle described with the height for a radius. So stated, the coincidence is certainly very striking. It by no means follows, however, that the ancient Egyptians were in possession of any *calculus* by which they could have arrived at a theoretical knowledge of the true ratio. It should be observed that the linear measures above mentioned are given only to entire inches, and those, inches of a scale which may or may not have been verified with extreme precision, and therefore can lay no claim to minute accuracy. Computing, moreover, on these measures alone, the ratio of the periphery to the height comes out 6·2784, while that resulting from the direct measure of the angle is 6·2878, the true ratio being 6·2832. The individual results differ by one 640th part of the whole quantity, and as we do not know with what instruments or what precautions the angle was measured, and it is given only to the nearest minute, it seems but reasonable to admit an equal proportional latitude of uncertainty in the original workmanship and in the numerical relation to which it was intended to conform. Now this is a very considerable approximation, much better than that of Archimedes a thousand years later. Still, it would be easy for people in possession of such appliances as they must have had at command, to ascertain the ratio in question to this, or even to a greater degree of precision, by tracing, for instance, on a flat pavement a circle of 100 feet in diameter and actually measuring the circumference. This they certainly might have done to the nearest half-foot, which, on a length of 314 feet, would correspond to such a latitude of error. If aware of the importance of the problem, they might have gone much further.

But, again, it by no means follows, from any thing which the dimensions of the Pyramid indicate, that they did possess a knowledge of the ratio of the circumference of a circle to its diameter, even approximately. By a very remarkable coincidence, which Mr. Taylor has the merit of having pointed out, the same slope, or one practically undistinguishable from it (51° 49′ 46″), belongs to a pyramid characterized by the property of having each of its faces equal to the square described upon its height. This is the characteristic relation which, Herodotus distinctly tells us, it was the intention of its builders that it should embody, and which we now know it did embody, in a manner quite as creditable to their workmanship as the solution of such a problem was to their geometry. This problem, however, has no relation to that of the rectification of the circle. The coincidence is one as purely accidental as any thing relating to abstract number can be; and although in solving the one problem which we know they did intend, they at the same time, practically speaking, resolved another which stands in no rational connexion with it, or any connexion beyond that of happening to have, very approximately, the same numerical solution, —we are not entitled to conclude that they were aware of this coincidence, and intended to embody *both* results in their building.

Another curious and novel relation, for pointing out which we are indebted to Mr. Taylor, is one ("Great Pyramid," page 37) which may be most intelligibly expressed under the following form of announcement, viz:—that a belt, encircling the globe, of the breadth of the base of the Great Pyramid, would contain one hundred thousand millions of square feet.[*] If the feet be Imperial Standard, and the belt Equatorial, this is approximate only to one part in 288 of the whole. But if we suppose the belt meridional, and the area expressed in "modular" square feet, the approximation is within one part in 1100. The fact is interesting as offering the only tolerable approach in round numbers to an arithmetical relation between any of the dimensions of this Pyramid and those of the earth.

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[*] Mr. Taylor has (*in words*) *one hundred millions*, which is a misprint.

Collingwood, April 23, 1860.

The Production of Photographic Images on Plates of Glass or Porcelain, by the Action of Light, enabling them to be permanently fixed by being Burnt in with Ceramic Colors.[*] By JOHN WYARD.

The plates of glass, or porcelain, or other substance, on which the pictures are to be produced, may be glazed prior to the application of the sensitive mixture, or otherwise this glaze or flux may be carried over the finished picture before burning. The first preparation of the plates after cleaning consists in the application of the following sensitive mixture:—

I make separate solutions of gum arabic and gelatine.

Gum Arabic, . .	72 grains.
Sat. Sol. Bichromate of Potass, .	½ oz. by measure.

Dissolve without heat.

Gelatine (Bell's) . .	15 grains.
Water, . .	1 oz. by measure.
Sat. Sol. Bichromate, . .	1 dr. "

Dissolve in a water bath. When cool, add the sol. bichromate.—Shake well and filter.

Take of the solution of—

Gum Arabic, . .	11 parts.
Solution of Gelatine, . .	5 "
Water Distilled, . .	5 "

To every dram of this mixture add 9 or 10 drops of honey syrup, formed by mixing equal parts in volume of honey and water, and filtering.

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[*] From the Journal of the Society of Arts, No. 385.

This mixture must be heated gently in a water bath, well shaken, and filtered through fine muslin.

The substance on which the picture is to be produced, opal glass, porcelain, ordinary kelp, or plate glass, is slightly warmed by a fire, and a sufficient quantity of the above sensitive mixture poured on, in the same manner as a collodion, drained off, and gradually dried before a fire. The film must be very even. A vigorous positive picture, either from a collodion negative, paper, or albumen, or even an engraving, must be placed in contact with the sensitive surface, and the whole exposed to light—sunlight if possible. The exact amount of exposure is a matter of great importance, from six to ten minutes in good sunshine is in most cases sufficient.

When removed from the light a negative image should be visible, the action of the light darkening and hardening the sensitive layer to a much greater degree when using the above mixture than when using plain gelatine. The sunned parts are harder, and the unsunned softer, than is the case with gelatine alone. The advantage I take of this hardening effect of light on the film of the above will be apparent in the next stage of the process.

I produce a positive image in ceramic color on the plate. This is effected by carrying over the surface of the plate the color in a fine state of division, by means of a pad of cotton wool, well charged with the required color. Its successful application requires some experience. The surface of the plate should be beaten gently and equally, not rubbed. The cotton should occasionally be breathed on, and re-charged with color. The color will be found gradually to adhere to the unsunned parts of the film, and its application should be continued until the picture is considered sufficiently powerful. Almost any amount of vigor may be obtained.

The picture is produced by the parts not exposed to light taking the color, and those portions exposed refusing to take it. The original negative image will now be almost lost to appearance by the superior density of the applied color, forming the positive picture, but there remains in the sensitive coating the changed and unchanged bichromate, which it is necessary to remove.

To effect this I apply alcohol to which has been added dilute acid in the proportion of six drops of the dilute acid to the drachm of alcohol.

The dilute acid contains 5 minims of ordinary nitric acid to the drachm of water. A bath of this may be used, or, if the subject is on a flat surface, the liquid can be poured on. While on the plate evaporation of the alcohol takes place; this would be equivalent to adding too much dilute acid to the alcohol, which would damage the film; therefore, in pouring on and off the liquid, care must be taken to keep up the proportion by adding a little pure alcohol occasionally.

When the brown color of the changed bichromate disappears the acid spirit must be poured off, and pure alcohol poured on and off; this must be repeated once or twice with fresh quantities, it being necessary to remove every trace of the acid and water.

The picture must be dried very rapidly, and is now ready for burning, provided the recipient has been previously covered with a flux or glaze, if not the flux may be applied over the picture in the following manner. Pour on a solution of Canada balsam in spt. turpentine.—Dry the plate by heat until the turpentine is entirely evaporated.

Prepare the flux, which may consist of borax and glass, or borax, glass, and lead, by grinding it on a slab with water, and drying. Apply this (the flux) equally and evenly, by means of a pad of cotton tied up in very soft and flexible leather.

With respect to the colors used, they are ground on a slab with water, and dried.

The red picture is obtained by peroxide of iron, prepared by calcining the sulphate, and washing the mass with successive lots of boiling water; the dark brown by oxide of manganese.

Photo-zincography.[*] By Colonel Sir Henry James, R.E., Director of the Ordnance Survey.

In the report of the committee of which Sir R. Murchison was chairman, it is stated that the annual saving effected by my having introduced this (the photographic) method of reducing the Ordnance plans from the larger to the smaller scales, amounted in the year 1858 to £1615. Since then we have so much reduced the cost of the photographs, that the saving which will be effected will amount to £35,000 in the cost of the survey. Up to this period we have exclusively used the paper prepared with nitrate of silver for printing the number of copies required; but we have made experiments with the printing paper prepared with the bichromate of potash, gum, and lamp black, or any other pigment, called the chromo-carbon process of printing.

The action of light on a coating of this composition produces the peculiar effect of rendering it insoluble in water, and consequently when a sheet of paper coated with it is placed in the printing frame under the collodion negative, the outline of the plan is rendered insoluble in water, and remains on the paper when all the remainder of the composition is washed away, and thus we have a "positive" plan in ink of any color which may be required.

In comparing the reduced plans obtained by this process with those obtained by the use of paper prepared with the nitrate of silver, we obtain no advantage whatever, but, on the contrary, the prints are less clear and sharp in their outline.

But by a new mode of treatment of these *chromo-carbon* prints which has been introduced by Capt. A. de C. Scott, R.E., who has charge of this branch of the work, and Lance-Corporal Rider, R.E., who is a good photographer, and also possesses a considerable knowledge of chemistry, we can produce very sharp, clear lines. The ink of the print after being soaked in a saturated solution of caustic potash or soda becomes, so to speak, disintegrated, and is then in a state which enables us at once to rub down the print and transfer the outline to the waxed surface of a copper plate for the engraver. This promises to be of great importance to us, as after obtaining the photographed reductions of the maps we have hitherto been obliged to make tracings from them in ink, for the purpose of transferring the plan to the copper, the expense and delay of which will now be saved, whilst we run no risk of any error being made by the draughtsman.

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[*] From the Lond. Mechanics' Magazine, April, 1860.

We have also tried a method which is still more valuable and by which the reduced print is in a state to be at once transferred to stone or zinc, from which any number of copies can be taken, as in ordinary lithographic or zincographic printing, or for transfer to the waxed surface of the copper plates. To effect this, the paper after being washed over with the solution of the bichromate of potash and gum, and dried, is placed in the printing frame under the collodion negative, and after exposure to the light, the whole surface is coated over with lithographic ink, and a stream of hot water then poured over it; and as the portion which was exposed to the light is insoluble, whilst the composition in all other parts being soluble is easily washed off, we obtain at once the outline of the map in a state ready for being transferred either to stone, zinc, or copper plate, or we can take the photograph on the zinc at once.

This new method of printing from a negative is extremely simple and inexpensive, and promises to be of great use to us. Sheet 96, of Northumberland, has been transferred to the copper plate from impressions taken from this process, and from the perfect manner in which we are able to transfer the impressions to zinc, we can, if required, print any number of faithful copies of the ancient records of the kingdom, such as "Doomsday Book," the "Pipe Rolls," &c., at a comparatively speaking very trifling cost. I have called this new method Photo-zincography, and anticipate that it will become very generally useful, not only to government, but to the public at large, for producing perfectly accurate copies of documents of any kind.

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*Singular Effect of Lightning.**

At the November Meeting of the Philosophical Society of New South Wales, held in the hall of the Australian Library, a very curious circumstance was brought under the notice of the members present, by Professor Smith, respecting the singular effect of lightning upon a gas-pipe. Alluding to the phenomenon, the Professor says:—

"In his laboratory at the University, recently, he had had a connexion made with the iron pipes brought up from the city; the gas-pipe was laid along the front of the building, below the surface of the ground. The pipe was a cast iron one, three inches in diameter, and the connexion with the laboratory was by a small iron pipe, joining a tin pipe, under the floor. There was also a system of lead water-pipes, following nearly the course of the tin gas-pipe, and terminating underneath the door-way, where the gas-pipe entered the laboratory; at this point, or just inside the door-way, the tin gas-pipe touched the lead

* From the Lond. Jour. of Gas Lighting, &c., No. 191.

water-pipe. On Monday afternoon, he left his gas-holder half full of gas—there was nearly twenty cubic feet in it. The stop-cock, between the outside pipe and the laboratory, was closed, and the junction with the gas-holder left open. On Tuesday morning, he tried to light the gas, but found there was none. On going round to ascertain the cause, he found that his gas-holder was empty, though all the stopcocks were shut; and then, on opening the outside stop-cock, he found that there was no pressure on the pressure-gauge, but he soon observed that the room was getting full of gas, from which he inferred that there must be somewhere in the pipe a hole as large as its diameter; otherwise, there would have been some pressure on the gauge. It then occurred to him that this accident might be connected with the fact that, on Monday afternoon, November 14, the University had been struck by lightning; in one of the shears on the tower a deep groove, an inch wide, had been cut out, and there was a terrific crash, suggesting to those in the building the idea that the roof had fallen in. There was a lightning conductor attached to a chimney of the laboratory, and this entered the ground eighteen feet from the gas-pipe, terminating six feet below the surface, in a large copper plate. On sending for the plumber who laid the pipes, he suggested that a rat had gnawn through the pipe on finding it obstructing his way; but, on taking up the flooring, they discovered that the accident must have been due to lightning. On the one side of the pipe, where it had touched the lead water-pipe, was an irregular oval aperture, about an inch long and half an inch wide, and right opposite, on the other side of the pipe, was a smaller rounded aperture, measuring half an inch by three-eighths, the tin being thinned away as if it had been beaten out. A lump of melted tin, weighing 45 grains, lay before the orifice. What had happened was tolerably clear. One of the pipes had been conveying a very powerful charge of electricity, and, coming to the point where it touched the other, the electricity preferred changing its route, and in leaping from the one to the other, it made two great holes. He observed that there was an indent in the lead water-pipe, and a piece of the lead melted. It was a puzzling thing to account for the hole at the back of the pipe. The corner of a brick touched it at that part, and the aperture there had quite a different appearance from that on the other side, the edge on one side (next the brick) being thin and sharp, while on the other it was thickened and melted. The blackening inside the pipe could be accounted for by the gas being decomposed by the electricity. There were many curious points connected with this case. In the first place, where did the lightning come from? He could scarcely imagine that the discharge could have come from the tower, and run along the pipe, which was buried in the ground for nearly two hundred feet. It seemed more probable that the discharge was delivered by the laboratory conductor, and had then passed through the ground to the gas-pipe, though that was eighteen feet away. He thought it might have come along the gas-pipe first, and then taken to the water-pipe as a better conductor. There was still another supposition, however; and, perhaps, the most probable one.

The lightning might have struck the south-east corner of the laboratory, and, being conducted by the lead gutter to the lead cistern under the roof, and thence down the water-pipe to the laboratory, making its exit by the gas-pipe. If this supposition be correct, it shows how limited was the protective power of the lightning conductor attached to a neighboring chimney. The man at the turnpike saw the lightning strike the University; he described it not as a flash of light, but as a ball of fire, which came down in front of the building. It was remarkable that the gas was not ignited by the electricity, and the laboratory set on fire."

A conversation ensued upon the subject, remarks being made upon the action of the lightning as very remarkable, and Professor Smith's explanations were considered fully satisfactory.

*Decay of Stone.**

Sir:—The cause of the destruction of the stone of the new places at Westminster is undoubtedly the sulphuric acid that is always present in the atmosphere of London, arising from the combustion of coal, which always contains a considerable per centage of sulphur. I noticed this destruction of the stone going on in 1854, when up in London giving evidence before a committee of the House. I then minutely examined the building, and found abundant evidence of decay. My attention was first called to this destructive action of the sulphuric acid in the atmosphere of large towns ten years ago. Having observed a white efflorescence on the bricks and stones of this town [Leeds] wherever there was damp, I analyzed and found it to be sulphate of magnesia and sulphate of lime. I also found sulphuric acid in the air. Combustion of coal is the only source whence so considerable a quantity of acid could be evolved into the air, as all coal contains about one per cent. of sulphur, whose combustion must keep the air of large towns always acid. This acid state of the air is causing serious damage here, as the only lime used is magnesian lime. The sulphate of magnesia formed is dissolved during rain, absorbed into the bricks or stones, and, when dry weather comes, it crystallizes and splits off the face of the bricks or stones like frost.

No magnesian stone or lime should be permitted in large towns, as the acid will act alike on the stone and mortar. The stone of the new palaces is magnesian limestone, and, unless a protection be found, all the mouldings and other parts liable to damp will rapidly decay.

As to the remedy proposed,—an alkaline silicate, or, as it is called, soluble glass,—will, in my opinion, be worse than the disease, as the acid atmosphere will decompose it as easily as the stone. The proper remedy will be to oil the stone with boiled linseed oil, which will prevent it being moist and attracting the sulphuric acid. The oil will not alter the color, and will effectually protect the stone.

C. L. Dresser, F.C.S.

*** Oiling, in the case of Caen stone, if not of others, is known to have failed.—Ed.

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* From the Lond. Builder, No. 863.

AMERICAN PATENTS.

AMERICAN PATENTS ISSUED FROM APRIL 1, TO APRIL 30, 1860.

Adding Numbers,—Machine for	D. R. Nelson,	Jackson,	Ohio,	24
Air Engines,—Compressed	W. C. Turnbull,	Baltimore,	Md.	17
Alarm Lock,	Joseph Ziegler,	"	"	10
Amalgamators,	I. W. Knox,	San Francisco,	Cal.	24
Artesian Wells,—Boring	John Taney,	Austin,	Texas,	17
Auger,	James Blake,	East Pepperell,	Mass.	17
Axe Handles,—Fastenings for	James E. Emerson,	San Francisco,	Cal.	10
Bank Notes,—Manufacture of	Augustus C. Carey,	Lynn,	Mass.	10
Barrel Heads,—Manufacturing	L. B. Batcheller,	Rochester,	N. Y.	3
Bed Bottom,—Spring	J. Bailey and J. Decamp,	Cincinnati,	Ohio,	3
Bed-cord Tightener,	A. B Stroup,	Waldron,	Ind.	10
Bed,—Spring	John H. Crane,	Charlestown,	Mass.	3
Bee-hives,	Robert Hawkins,	Bealsville,	Penna.	24
Beer Pitcher,	L. Hermance,	Saratoga Spr's,	N. Y.	17
Bells,—Hanging	T. H. Bell,	Washington,	D. C.	17
Belt Fastening,	G. W. Blake,	Pepperell,	Mass.	24
Belting,	Henry Underwood,	City of	N. Y.	10
——,—Making Rubber	Thomas J. Mayall,	Roxbury,	Mass.	3
Bench Planes,	H. C. Hunt,	Ottumwa,	Iowa,	24
—— Vise,	L. A. Beardsly,	S. Edmeston,	N. Y.	24
Boilers for Hot water apparatus,	Edmund B. Cherevoy,	City of	"	10
Bolts,—Heading	Hiram Abbott,	Wakeman,	Ohio,	17
Bonnet Frames,—Manuf. of	R. T. Wilde,	City of	N. Y.	24
Boots and Shoes,—Planes for	E. S. Snell,	N. Bridgewater,	Mass.	10
————,—Heels for	J. V. Dinsmore,	Auburn,	Maine,	3
————,—Overshoes &	McEwen and Patterson,	Kingston,	Tenn.	17
Boxes,—Finishing Wooden	H. A. Jones,	St. Louis,	Mo.	24
——,—Metal Caps for	Deidrich and Slocum,	Philadelphia,	Penna.	3
Bridges,—Truss	G. O. Bishop,	Hannibal	Mo.	24
Brooms,—Metal Head for	H. G. Smith,	Muscatine,	Iowa,	3
Buckles,	John C. Hall,	Fayette,	Miss.	3
Bullet Ladle,	George Rugg,	Potsdam,	N. Y.	24
Burglars Alarm,	George W. Bigelow,	New Haven,	Conn.	10
Butt Hinges,	George H. Fayman,	Washington,	D. C.	10
Candle Machines,—Making	Michael Massey,	Cleveland,	Ohio,	24
Candles,—Moulding	William Thomas,	City of	N. Y.	3
Cane Presses,	Eugene Powell,	Conneautville,	Penna.	10
Caoutchouc,—Vulcanizing	Asahel K. Eaton,	Kings County,	N. Y.	3
————————	Charles T. Harris,	N. Brunswick,	N. J.	10
Car Axles,	L Brown, & J & J Leland,	Worcester,	Mass.	24
— Couplings,	Ruel Rawson,	Quincy,	Mich.	3
Carpenters Clamp,	John Cadwell,	Cincinnati,	Ohio,	24
Carpet Beater and Cleaner,	A. Cutler & E. S. Wright,	City of	N. Y.	10
Carriage Seats,—Sliding	Wm. A. Bird,	Newark,	N. J.	17
——— Springs,	Edward Maynard,	Brooklyn,	N. Y.	3
Cartridge Cases,	George P. Foster,	Providence,	R. I.	10
Cartridges,—Filling Metallic	H. Smith & D. B. Wesson,	Springfield,	Mass.	17
Carving Marble, &c.,	William H. Pease,	Goshen,	Ind.	10
Chair Caster,	Thomas Fry,	Brooklyn,	N. Y.	10
Cheese Presses,	Myron E. Taft,	Potsdam,	"	10
Chucks for cut'g Discs of paper,	Mathaus Kaefer,	City of	"	10
Churn,	Daniel Deshon (2d),	Somerset,	Penna.	3
———	Edward Lynch,	Buffalo,	N. Y.	10
———	S. P. Dunham & A. Hipple,	Kilbourne,	Ohio,	17
———	Jehu Mitchell,	Aleppo towns'p,	Penna.	17
Cigar and Match Cases,	P. J Clark,	West Meriden,	Conn.	3
Clocks,—Winding Spring of Air	Charles B. Hoard,	Watertown,	N. Y.	3
Clock Weights,—Constructing	Richard F. Bond,	Cambridge,	Mass.	3

Clothes-wringer, .	Elliot Dickerman,	Richmond,	Vt.	1
Coal and Ores,—Purification of	Jesse Burroughs, .	Ridgway,	Penna.	
——, &c.,—Buckets for remov'g	J. S. Lloyd, .	Salem,	N. J.	2
Combs, .	E. M. Noyes, .	Newark,	"	2
Coopers' Tool, .	J. P. Woods, .	Troy,	N. Y.	1
Corn Harvesters, .	Adam Humberger, .	Somerset,	Ohio,	
—— Huskers, .	N. T. Spear, .	City of	N. Y.	1
—— Planters, .	G. W. N. Yost, .	Yellow Springs,	Ohio,	
———— .	Martin A. Howell, Jr.,	Ottawa,	Ill.	1
—— Shellers, .	Nathaniel Drake, .	Newton,	N. J.	
—— Shock-binders, .	Calvin Stowe, .	Braceville,	Ohio,	2
Cotton Thinning Ploughs,	L. B. Joyner, .	Hilliardston,	N. C.	2
——— Bales,—Metal Hoops on	John McMurtry,	Fayette Co.,	Ky.	1
——— Seed Planters,	S. P. Sweeney, .	Columbia,	Texas,	
Coupling Attachment for Cords,	J. L. Howard, .	Hartford,	Conn.	1
Cradle,—Child's .	L. K. Selden, .	Haddam,	"	1
———,—Infant's .	S. F. Brooks, .	Weston,	Mass.	2
Crank,—Overcoming Points of	John P. Cooper, .	Finleyville,	Penna.	
Cultivator Teeth, .	Heman B. Hammon,	Bristolville,	Ohio,	1
———— .	G. C. Aiken, .	Nashua,	N. H.	2
Cultivators, .	W. B. Dorsay, .	Decatur,	Ill.	
———— .	John G. Christopher,	Byron,	"	1
———— .	J. F. Eylar, .	Scott,	Ohio,	2
———— .	I. R. Smith, .	Elgin,	Ill.	2
————,—Corn & Cotton	G. T. Bennett, .	Mount Olive,	N. C.	2
————,—Hand .	P. S. Clinger, .	Conestoga Cen.	Penna.	
Curtain Fixture, .	Edward Brown,	Waterbury,	Conn.	
———— .	Joseph Smith, .	City of	N. Y.	
————,—Window	Tanner and Gorton,	Paw Paw,	Mich.	
Cutlery,—Securing Handles of	R. H. Fisher, .	Beverly,	N. J.	1
Door Numbers,—Casting	J. T. Fuller, .	Louisville,	Ky.	1
Eave Troughs,—Making	Loomis Mann, .	Ionia,	Mich.	1
Egg-beater, .	J. M. Jay and J. Danner,	Canton,	Ohio,	1
Elevators for Hay, &c., .	F. F. Fowler, .	Crane towns'p,	"	1
Emery Cloth,—Substitutes for	Thomas J. Mayall,	Roxbury,	Mass.	1
Enameling Mouldings, Machine	Richard Ten Eyck, Jr.,	Brooklyn,	N. Y.	2
Etching Stone,—Composition for	A. Hoen, .	Baltimore,	Md.	2
Evaporators,—Rotary .	A. H. Miller, .	La Porte,	Ind.	2
Excavators,—Dirt-loading for	William Cooper,	Mount Gilead,	Ohio,	
Eyelet Machines, .	William Steinmetz, .	Philadelphia,	Penna.	1
Faucets,—Measuring,	George K. Babcock,	Utica,	N. Y.	
Fence,—Making Picket .	J. Moore and A. Kelly,	Pittsburgh,	Penna.	1
Fertilizers,—Sowing .	William D. Mason,	Jarrett's Depot,	Va.	
Fibrous Materials,—Reducing	S. M. Allen, .	Niagara Falls,	N. Y.	1
Figures, &c.,—Copying .	F. C. Meyer, .	Philadelphia,	Penna.	2
Files, .	Pietro Cinquini, .	West Meriden,	Conn.	
Fire-arms,—Breech-loading	J. Letort & H. S. Matthews,	Wytheville,	Va.	
————	Calvin Cox, .	Coxville,	N. C.	1
————	G. P. Foster, .	Providence,	R. I.	1
————,—Revolving .	F. D. Newbury, .	Albany,	N. Y.	1
Fire Escape, .	Deckelman and Spiess,	City of	"	2
———— .	Adolphus Lippman, .	"	"	2
—— Ladders,—Truck for	Mickle and Carville,	"	"	1
—— Places, .	James K. Ross, .	Lebanon,	Ohio,	
———— .	T. F. Card, .	Cincinnati,	"	1
—— Plugs,—Casting .	Wm. M. and J. B. Ellis,	Washington,	D. C.	1
Fire-proof Safes, .	Gregor Menzel, .	Milwaukie,	Wis.	2
Flour Separators, .	Stephen Hughes, .	Hamilton,	Ohio,	1
Fluid Lenses, .	Seligman Kakeles,	City of	N. Y.	2
Fly Brush or Fan, .	Marcus Laveen, .	Moorefield,	Va.	1
Forge Bellows, .	William Thompson,	Detroit,	Mich.	1
Fork and Spoon,—Culinary	Andrew Hills, .	Naugatuck,	Conn.	1
Furnaces, .	Peter Low, .	Cincinnati,	Ohio,	

Garden Hoes,	John R. Albertson,	E. Deertowns'p,	Penna.	3
Gas,—Instruments for Lighting	Damarin and Brower,	New Orleans,	La.	24
—— Lights,—Reflector for	Isaac P. Frink,	Newark,	N. J.	17
—— Metres,—Dry	Charles L. Vasquez,	Philadelphia,	Penna.	10
—— Retorts,—Siphons to	Harvey Guild,	New Orleans,	La.	3
Gases,—for Generating	Samuel Chamberlaine,	Philadelphia,	Penna.	10
Glass Moulds,	C. H. Warner,	Brooklyn,	N. Y.	10
Grain by Sulph. acid,—Bleach'g	J. M. Clark,	Philadelphia,	Penna.	17
—— Drying Machines,	T. H. McCulloch,	Peoria,	Ill.	17
—— Scales,—Automatic	Albert Gummer,	Indianapolis,	Ind.	3
—— Separators,	Jacob Schaefer,	Henderson,	Ky.	10
——————	J. H. McGehee,	Athens,	Ala.	17
——————	George Westinghouse,	Schenectady,	N. Y.	17
——————	J. A. Vaughn,	Cuyahoga Falls,	Ohio,	24
——,—Weighing	John Williams,	Kalamazoo,	Mich.	10
Gum from machinery,—Remov'g	Samuel Maxwell,	Baltimore,	Md.	24
Hammers,—Atmospheric	Milo Peck,	New Haven,	Conn.	17
Hand Trucks,	Jonas Underkofler,	Philadelphia,	Penna.	24
Harness Pads,	James Ives,	Mount Carmel,	Conn.	24
Harvesters,	Jacob L. Paxson,	Norristown,	Penna.	10
————	Lewis C. Reese,	Phillipsburgh,	N. J.	10
————	A. and N. Kane,	City of	N. Y.	24
————,—Cutting appa's for	George Fetter,	Philadelphia,	Penna.	3
————,—Rakes for	W. P. Penn,	Belleville,	Ill.	24
Harvesting Machines,	Bennett F. Witt,	Dublin,	Ind.	10
——————	Martin Hallenbeck,	Albany,	N. Y.	17
Hat Rack for Cigars, &c.,	Charles Branwhite,	Williamsburgh,	“	24
Hats,	J. R. Ender,	Trenton,	La.	17
——,—Manufacture of	Warburton and Lovett,	Philadelphia,	Penna.	10
——,—Ventilators for	James Jenkinson,	Brooklyn,	N. Y.	24
——————	Julius Pollock,	Morrisania,	“	3
Head-supporting Apparatus,	Henry C. Howells,	City of	“	10
Heat Radiators,	D. G. Fletcher,	Racine,	Wis.	17
Hoisting Hay, &c.,—Machines	J. S. Lloyd,	Salem,	N. J.	24
Hoisting Wheels,—Operating	John McMurtry,	Fayette Co.,	Ky.	3
Horses Feet from Interfering	William Somerville,	City of	N. Y.	24
————,—Stopping Runaway	Joseph Koehler,	“	“	17
Horse-powers,	Charles S. Graves,	Elyria,	Ohio,	10
—————	E. B. Requa,	Jersey City,	N. J.	17
—————	Otis W. Stanford,	Cincinnati,	Ohio,	24
Horse-shoe Machine,	T. R. Taylor,	Cleveland,	“	3
Hose Tubing,	Charles McBurney,	Roxbury,	Mass.	10
on,—Manufacture of	W. G. Brown & F. McKee,	Birmingham,	Penna.	3
——,—Welding Wrought	J. C. Cooke,	Middletown,	Conn.	3
ournal Boxes,	I. P. Wendell,	Philadelphia,	Penna.	10
nife and Fork Cleaner,	Sewall Brackett,	Fall River,	Mass.	10
—— Sharpener and Cleaner,	John M. Farman,	Hartford,	Conn.	17
adder,—Extension	Mickle and Carville,	City of	N. Y.	10
adders,—Extension	F. Kavemann and others,	Cincinnati,	Ohio,	24
anterns,	P. A. Morley,	Brooklyn,	N. Y.	17
————	T. B. DeForest,	City of	“	10
athes,	John Cook,	Buffalo,	“	3
eather-dressing Machine,	R. P. Boyce,	Erata,	Miss.	17
etter-copying Presses,	G. C. Taft,	Worcester,	Mass.	24
ightning Rods,—Insulating &c.	Myron Fox,	Stamford,	Conn.	24
ock,	William E. Worthen,	City of	N. Y.	10
—— and Label sheath,—comp.	Samuel W. Marsh,	Washington,	D. C.	3
ocomotives,— Guide Wheels for	Septimus Norris,	Philadelphia,	Penna.	24
ocom. Engs.,—Running Gear	John L. Whetstone,	Cincinnati,	Ohio,	10
ooking-glass or Mirror,	S. F. Brooks,	Weston,	Mass.	24
ooms,	James C. Cooke,	Middletown,	Conn.	10

Looms,	Hezekiah Conant,	Willimantic,	Conn.	10
Lubricating Carriage Axles,	James E. Emerson,	San Francisco,	Cal.	17
Mail Bags, &c.,—Labels for	T. P. Trott,	Washington,	D. C.	24
Mangers,	John E. Kelly,	City of	N. Y.	10
Mangle,	George Coombs,	West Falls,	"	17
Match Case,—Portable	D. Ellis and P. Hine,	Waterbury,	Conn.	24
Mills,—Grinding	Edmund Munson,	Utica,	N. Y.	3
Millstone Bush,	Moses French,	Leesville,	Ind.	3
Molasses Gates,—Casting	M. R. Chace,	Fall River,	Mass.	24
Mortising Machine,	Lovett Eames,	Kalamazoo,	Mich.	17
——— Tool,	"	"	"	10
Mosquito Fan,—Automatic	Charles A. Gale,	Boston,	Mass.	10
Mowing Machines,	S. Ray & M. P. Shalters,	Alliance,	Ohio,	10
Needle Case,	T. G. Harold,	Brooklyn,	N. Y.	24
——— Guards,	Joseph C. Howells,	Madison,	Wis.	10
Oil Cans,	William C. Arthur,	Baltimore,	Md.	10
—- Cock,	James Hare, Jr.,	Paterson,	N. J.	17
—,—Distillation of Coal	Stombs and Brace,	Newport,	Ky.	10
Oils,———	Luther Atwood,	City of	N. Y.	10
—,———Hydro-carb.	"	"	"	10
Ore,—Apparatus for Heating	A. C. Vandyke,	Greenupsburg,	Ky.	24
Ores of Zinc, &c.,—Operations to	Robert George,	Mineral Point,	Wis.	3
Paddle Wheel,	Rollin Germain,	Buffalo,	N. Y.	10
Padlock,	Wilson Bohannan,	Baltimore,	Md.	17
Paper-bag Cutter,	L. D. Barraud,	City of	N. Y.	24
Pen and Pencil Case,	John Cockburn,	"	"	10
—— Stand,	Rooney and Renshaw,	"	"	3
Planes in Moulding,—Adjusting	W. D. Jones,	Dayton,	Ohio,	24
Ploughs,	D. H. and E. E. Smith,	Glenn Spring,	S. C.	3
———	A. Hammond,	Jacksonville,	Ill.	10
———	William D. Ivey,	Milford,	Ga.	10
———	M. C. McCullers,	Herndon,	"	24
———,—Mole	Wall, Roberts & Carter,	Decatur,	Ill.	10
———,—Seeding	C. Atkinson,	Vermont,	"	10
—————	James Peeler,	Tallahassee,	Fla.	24
Printing Presses,	F. O. Degener,	City of	N. Y.	24
Prussian Blue,—Manufacture of	Theodore A. Helwig,	Minersville,	Penna.	3
Pumps,	Cornelius Hood,	Seneca Falls,	N. Y.	17
———	Henry Belfield,	Philadelphia,	Penna.	17
———	Robert Ramsden,	S. Easton,	"	24
———	Levi Matthews,	Antrim,	Ohio,	24
Pumping Water,—Wind Mach.	F. G. Johnson,	Sag Harbor,	N. Y.	3
Pump Valves,	William Jeffers,	Pawtucket,	R. I.	17
Punches,	Adoniram J. Fullom,	Springfield,	Vt.	10
Quartz,—Machines for Crushing	Jefferson Short,	Leavenworth,	K. T.	17
——— Mills,—Grind. Surfaces	Ezra Coleman,	City of	N. Y.	3
Railroad Axle Boxes,	Harvey Rice,	Concord,	N. H.	3
——— Car Axles,	James Montgomery,	Baltimore,	Md.	24
——— Cars,	S. J. Seely,	Buffalo,	N. Y.	24
————,—Brakes for City	Jenks and Steere,	Providence,	R. I.	17
————,—Framing of	Thomas M. Mullen,	Philadelphia,	Penna.	3
————,—Running Gear	Richard Hornbrook,	Cincinnati,	Ohio,	24
————,—Starting City	Solomon N. Sanford,	Cleveland,	"	3
——— Rails, &c.,—Wear of	C. T. Liernur,	Mobile,	Ala.	17
Railroads,—Tracks for City	S. M. Fox,	City of	N. Y.	24
Rakes,—Horse	Lorenzo Beach,	Montrose,	Penna.	10
Reflector,—Night-light	John Wyberd,	City of	N. Y.	10
Refrigerator,	W. M. Baker,	Walpole,	Ind.	3
Roofing,—Board	Freeman Walcott,	Milford,	Mass,	10
Rotary Motion,—Reciprocat'g to	Joshua Hathaway,	Marietta,	Ga.	3

Saddles,—Riding .	John E. Kelly, .	City of	N. Y.	3
——— .	Mortimer Nelson,	"	"	10
Sashes,—Metallic	W. E. Worthen, .	"	"	24
Sausage-stuffer, .	Christian Kramer,	Alleghany,	Penna.	3
——— .	Salmon R. Plumb, .	Southington,	Conn.	10
——— .	John G. Perry, .	S. Kingston,	R. I.	10
Saw-filer, .	J. S. Tripp, .	Danby,	N. Y.	17
Saw-mills, .	C. P. Morton, .	Philadelphia,	Penna.	24
Saws, .	Pearson Crosby, .	City of	N. Y.	10
Scaffolds,—Builders' .	John K. Lemon,	Toledo,	Ohio,	10
Scales, .	H. N. and J. C. Bill,	Willimantic,	Conn.	3
Scissors, .	Francis B. Bowman,	Waltham,	Mass.	3
Seed Planters, .	John Robinson, .	Sharptown,	Md.	17
Seeding Harrows, .	William Finlay,	Schoolcraft,	Mich.	10
——— Machines,	James F. Gyles, .	Gilmer towns'p,	Ill.	3
——— .	Alonzo R. Root, .	Canton,	Mo.	3
———	A. and R. B. McElroy,	Waupun,	Wis.	3
——— .	F. Chamberlin, .	Berlin,	"	10
———	Thomas Lindsey, .	Lincoln,	Ill.	10
———,—Broadcast	John Barnes, .	Lima,	N. Y.	24
Sewing Machines, .	Thomas Newlove, .	Chicago,	Ill.	3
———	Warren Millar, .	"	"	10
——— .	Allen & Molyneux, .	Bordentown,	N. J.	17
———,—Driv. mech.	Jonas Perkins, .	Braintree,	Mass.	17
——— Machine,—Stitch of a	J. S. McCurdy, .	Brooklyn,	N. Y.	24
——— Machines,—Tension ap.	C. G. Cross, .	Chicago,	Ill.	17
——— Mach. needles,—thread'g	John Stevens, .	City of	N. Y.	3
Sextant, .	Louis Daser, .	Washington,	D. C.	17
Sheet Metal,—Cutting	John Waugh, .	Elmira,	N. Y.	24
Shingle Machines,—Tilt'g bolt	Tyrannus P. Butterfield,	Indianapolis,	Ind.	3
Shirt Stud, .	Henry Simon, .	Providence,	R. I.	10
Shoemakers' Awls, .	B. J. Lane, .	S Framingham,	Mass.	17
Show-case Doors, .	Daniel Barclay, .	Chicago,	Ill.	24
Skates, .	Bradford Stetson,	Uxbridge,	Mass.	24
Slate,—Artificial .	Thomas J. Mayall, .	Roxbury,	"	10
—— Roof,—Laying .	Isaac Mott, .	Glenn's Falls,	N. Y.	10
Sofa Bedstead, .	William H. Tendler,	Cambridge,	Mass.	10
Sowing Machines, .	W. W. Williams,	Elizabeth City,	N. C.	3
Staging-supporter for mechanics,	Azel Reynolds, Jr., .	N. Bridgewater,	Mass.	17
Steam Boiler, .	Stone and Whipple,	Roxb'y&Boston,	"	10
——— .	E. W. Tarbell, .	Boston,	"	17
——— .	B. H. Wright, .	Rome,	N. Y.	24
——— Boilers, .	James Montgomery, .	Baltimore,	Md.	17
———,—Feed Water	Thomas Snowdon,	Pittsburgh,	Penna.	3
———	C. and G. M. Woodward,	City of	N. Y.	10
———	Henry Giffard, .	Paris,	France,	24
———	G. W. Rains, .	Newburgh,	N. Y.	24
———,—Gauge, &c., for	James Montgomery,	Baltimore,	Md.	24
———,—Spark-extin.	D. S. Harris, .	Galena,	Ill.	10
———,—Test'g floats	George W. Lane,	Boston,	Mass.	3
——— Carriages, .	J. V. Merrick, .	Philadelphia,	Penna.	17
——— Engines, .	Frank Douglas, .	Norwich,	Conn.	3
——— .	Ormrod C. Evans, .	City of	N. Y.	10
———,—Gov. Valves of	P. L. Weimer, .	Lebanon,	Penna.	3
———	Edward Armstrong, .	Pittsburgh,	"	3
———	P. L. Weimer, .	Lebanon,	"	17
——— Generators, .	R. E. Rogers, .	Philadelphia,	"	17
——— Trap Valve,	John Avery, Jr., .	City of	N. Y.	10
——— .	Daniel Lee, .	Boston,	Mass.	17
Steel,—Manufacture of	A. K Eaton, .	City of	N. Y.	3
Steering Apparatus, .	William W. Huse, .	Brooklyn,	"	10
Stones,—Machines for Breaking	E. W. Blake, .	New Haven,	Conn.	17
———,—Crushing .	G. H. Wood, .	Green Bay,	Wis.	24

Stones,—Stamping & Crushing	Jeremiah Stever,	Bristol,	Conn.	
Stoves, . .	W. J. Cantilo, .	Philadelphia,	Penna.	2
———,—Cooking	Joseph C. Henderson,	Albany,	N. Y.	
Straw-cutters, .	C. B. Mallory, .	Fredonia,	"	
——— .	Root and Lloyd, .	Muncy,	Penna.	1
Stump Extractors, .	L. C. English, .	Canton,	N. Y.	1
———	Caleb Bates, .	Kingston,	Mass.	1
Sugar Cane,—Crushing	Theodore Grundman,	Freeport,	Ill.	1
——— Holder & Distributor,	Thomas Lewis, .	Malden,	Mass.	
——— Juices,—Evaporating	Seth W. Eells, .	Mansfield,	Ohio,	1
——— Mills, .	G. W. L. Hazen,	Indianapolis,	Ind.	1
———,—Crushing Rollers	Philetus W. Gates, .	Chicago,	Ill.	1
Sweeping Streets, .	Robert A. Smith,	City of	N. Y.	1
Swing,—Portable	L. K. Selden, .	Haddam,	Conn.	2
Tanning, .	David Needham,	Oskaloosa,	Iowa,	1
———,—Concen. Extracts	James Connell, .	Port Huron,	Mich.	1
———,—Method of .	M. A. Bell, .	Rushford,	N. Y.	2
Teeth,—Fastening Artificial	A. M. and J. L. Asay,	Philadelphia,	Penna.	
Telegraph Wires,—Insulating	John M. Batchelder,	Cambridge,	Mass.	1
Temples for Looms, .	J. H. Woodward, .	Nashua,	N. H.	2
Thread and Yarn,—Manufac. of	S. M. Allen, .	Niagara Falls,	N. Y.	1
Thills to Vehicles,—Attaching	L. W. Boynton, .	City of	"	
Tire,—Upsetting .	Leonard Kile, .	Williamsfield,	Ohio,	1
Tobacco Presses, .	E. S. Collins, .	Aspen Wall,	Va.	1
Tombstones, .	Thomas Windell,	New Albany,	Ind.	2
Trap,—Animal .	Levi W. Buxton, .	Nashua,	N. H.	2
Traveling Bags, .	T. R. Dunham, .	Newark,	N. J.	2
Trip Hammer, .	David Howell, .	Louisville,	Ky.	1
Valves, .	Joseph Higginbotham,	Philadelphia,	Penna.	1
Vapor Burners, .	Edward H. Anderson,	Easton,	Md.	
——— .	Hopkins & Anderson,	"	"	
——— .	Oscar F. Morrill, .	Boston,	Mass.	
——— Lamps, .	Henry Johnson, .	Washington,	D. C.	1
Varnish, .	André Sabatier, .	City of	N. Y.	1
Veneers,—Machines for Cutting	David Donald, .	"	"	1
———	Koch and Stoeckel, .	"	"	2
Vessels of Sheet Metal,—Form'g	J. B. Jones, .	Brooklyn (E D),	"	1
Voting Register, .	J. W. Wetmore, .	Erie,	Penna.	
Vulcanized Rubber,—Restoring	C. F. E. Simon, .	Washingtont'n,	N. J.	1
Walls,—Building Concrete	Elizur E. Clark, .	New Haven,	Conn.	
———	" .	"	"	2
Warming Apparatus,—Draft in	Brown and Ellis, .	City of	N. Y.	
Washboard, .	Joseph Keech, .	Waterloo,	"	1
——— .	Edward Hatfield, .	Brownsville,	Penna.	1
Washing Machine, .	Burgan B. Wescott,	Camden,	Ind.	1
———	Patterson and Morell,	Woodbury,	N. J.	1
——— .	Josee Johnson, .	City of	N. Y.	1
———	Sharp and Mood,	Ithaca,	"	1
——— .	H. C. Smith, .	Cleveland,	Ohio,	1
———	C. K. Williams, .	Haddonfield,	N. J.	1
——— .	G. W. Tolhurst, .	Liverpool,	Ohio,	2
Water Elevators,	James Aldrich, .	Washington,	D. C.	1
Well Buckets, .	Daniel D. Farnham, .	Johnstown Cen.	Wis.	
Wheels for Artillery Carriages,	John D. Murphy,	Baltimore,	Md.	
Whiffle-trees,—Self-detaching	S. D. Bowker, .	Geneva,	Ohio,	1
Window-blind Slat Machine,	H. W. Farmer, .	Poultney,	Vt.	2
Window-sash Supporters,	J. W. Briggs, .	Cleveland,	Ohio,	1
Window Sashes, .	McCoy and Muth,	Wheeling,	Va.	2
———,—Supporting	David C. Lyall, .	City of	N. Y.	1
Wind-mills, .	E. F. M. Fletcher,	Georgia Plains,	Vt.	1
Wood,—Polishing	George Munger, .	New Haven,	Conn.	1
Wooden Ware,—Making	Ansel Howard, .	Readsborough,	Vt.	1
Writing Desk,—Reading and	Carl Pretsch, .	Trenton,	N. J.	1

EXTENSIONS.

Curry-combs,	William Wheeler,	New Britain,	Conn.	17
Door Locks,	Joshua H. Butterworth,	Dover,	N. J.	3
Hat-bodies,—Making,	Eliza Wells,	City of	N. Y.	24
———,—Manufacturing	"	"	"	24
Printing Presses,—Checking	Alva B. Taylor,	"	"	3
Saw-mills,	Thomas J. Wells,	"	"	3
Stoves,—Registers of	Washburn Race,	Seneca Falls,	"	10
Telegraphs,—Electro-magnetic	S. F. B. Morse,	Poughkeepsie,	"	17
Telegraph,—Mag. Letter Print'g	R. E. House,	Binghampton,	"	24

ADDITIONAL IMPROVEMENTS.

Canal Boat Propellers,	Robert Cartwright,	Ithaca,	N. Y.	3
Coffee Pots,	H. P. Gatchell,	Ravenna,	Ohio,	3
Harvesters,—Cutters for	John Gore,	Brattleboro',	Vt.	10
Windlasses,—Ship's	James Emerson,	Boston,	Mass.	3

RE-ISSUES.

Boiler-feeder,—Automatic	S. B. Hunt,	City of	N. Y.	24
Enameling Moldings,	Robert Marcher,	"	"	3
Folding Paper,	George K. Snow,	Watertown,	Mass.	3
Knitting Machines,	Clark Tompkins,	Troy,	N. Y.	24
Looms for Figured Fabrics,	Moses Marshall,	Lowell,	Mass.	24
Manure Excavators,	Abraham R. Hurst,	Chambersburg,	Penna.	3
Matrices,—Mode of constructing	J. C. Smith,	Philadelphia,	"	10
Planing Lumber "out of Wind,"	S S Gray & S A Woods,	Boston,	Mass.	17
Railroads,—Dispensing switches	Wm. Wharton, Jr.,	Philadelphia,	Penna.	3
Stoppers for Bottles,—Glass	T. R. Hartell,	"	"	24
Stoves,—Coal	C. Eddy and J. Shavor,	Troy,	N. Y.	10
Straw-cutters,	Warren Gale,	Chicopee Falls,	Mass.	3

DESIGNS.

Andirons, (2 cases,)	Samuel Boyd,	City of	N. Y.	3
Carpets,	David McNair,	Roxbury,	Mass.	3
———,	Francis J. Pierce,	Lowell,	"	3
Coffins,	James C. Karr,	Williamson co.,	Tenn.	3
Cooking Range,	J. Martino & J. Horton,	Philadelphia,	Penna.	10
Fire-dogs (6 cases,)	Theodore W. Lillagore,	"	"	3
Floor Cloth,	Jeremiah Meyer,	City of	N. Y.	24
—— Oil Cloth,	J. B. Virolet,	"	"	24
ce Pitchers,	George W. Smith,	Hartford,	Conn.	3
Paint Cans, (3 cases,)	W. L. Gilroy,	Philadelphia,	Penna.	24
—— Vessels,	"	"	"	24
poon Handles,	John Polhamus,	City of	N. Y.	10
Lead Pencils,—Stamping on	Joseph Rosenthal,	"	"	3
toves,	N. S. Vedder,	Troy,	"	24
———,—Parlor	Isaac De Zouche,	St. Louis,	Mo.	24
Trade-marks for Lead Pencils,	Joseph Rosenthal,	City of	N. Y.	3
Trade-mark for Neuralgic Pills,	Samuel Armitage,	St. Louis,	Mo.	3
Water Coolers,	Charles Muller,	City of	N. Y.	3

FRANKLIN INSTITUTE.

Proceedings of the Stated Monthly Meeting, June 21, 1860.

John C. Cresson, President, in the chair.

John Agnew, Vice-President, }
Isaac B. Garrigues, Recording Secretary, } Present.

The minutes of the last meeting were read and approved.

Donations to the Library were received from the Royal Astronomical Society, The Chemical Society, and the Institute of Actuaries of London; the Oesterreichischen Ingenieur-Vereines, Vienna, Austria; the Regents of the University of New York, Albany, N. Y.; F. H. Storer, Esq., Cambridge, Mass.; the Ohio Mechanics' Institute, Cincinnati, Ohio; the State Agricultural Society, Madison, Wisconsin; and from Dr. Alexander Wilcocks, Prof. John F. Frazer, and the American Philosophical Society, Philadelphia.

The Periodicals received in exchange for the Journal of the Institute, were laid on the table.

The Treasurer read his statement of the receipts and payments for the month of May.

The Board of Managers and Standing Committees reported their minutes.

Candidates for membership in the Institute (5) were proposed, and the candidates proposed at the last meeting (4) duly elected.

In compliance with a request from the Committee on Meetings, the President gave a brief description of the large balloon of Professor Lowe, with which he proposes to attempt a transatlantic voyage. Its dimensions were stated to be 110 feet in horizontal diameter, and about 120 in height; the cubical capacity being 700,000 cubic feet. The idea of the æronaut is to inflate with about one-half the quantity of gas the balloon will hold, so as to allow room for expansion as the machine rises. The buoyancy of the ordinary coal gas being about 40 ℔s. to the thousand feet, the buoyant power with this degree of inflation will be about 14,000 ℔s., of which about 5000 ℔s. will be required to sustain the balloon and trappings, including a life-boat, with sails, &c. The remaining floating power beyond the weight of passengers and provisions, will be balanced by portable ballast, which is to be thrown overboard as occasion requires. Prof. Lowe expects to rise to the height of three miles, and there travel East-by-North in the prevailing upper current of the atmosphere, which he supposes to have a velocity of nearly 100 miles an hour, and will therefore waft him across the Atlantic in less than two days.

COMMITTEE ON SCIENCE AND THE ARTS.

Report on Ritchie's Rhumkorff's Induction Apparatus.

The Committee on Science and the Arts constituted by the Franklin Institute of the State of Pennsylvania, for the promotion of the Mechanic Arts, to whom was referred for examination—"An Improvement on Rhumkorff's Induction Apparatus," by E. S. Ritchie, of Boston, Massachusetts,

Report:—That, as it appears from the description of the apparatus by Mr. Ritchie, hereto annexed; his apparatus differs from those made before him in the following particulars:—

In making the primary helix of greater diameter, and of larger wire; the iron core is made longer than the helix; the primary helix is insulated more thoroughly from the secondary, by a glass bell with a broad flanch below, on which the secondary coil rests; the secondary coil is wound differently, in place of winding in successive helices, it is wound by spirals alternately outward and inward, beginning with the base. In this way, it will be seen that between any two points nearly in contact, there is less difference of intensity than in the old mode, and thus less thickness of insulating material is required, and a greater length of coil can be put within the inductive influence. This secondary helix is also more carefully covered with insulating material; the condenser (which is Fizeau's invention) is divided into three sections, so that the power of the instrument may be modified by the use of one, two, or all of the parts. The interrupter is modified and placed under the control of the operator, by which a more sudden and slower brake can be made, and thus the power of the instrument increased.

The Committee have experimented upon the apparatus constructed by Mr. Ritchie, for the Department of Arts of the University of Pennsylvania, and they find that this apparatus excited by three cells of a carbon battery, the zincs of which are five inches in diameter and eleven inches in height, is capable of giving a spark of eleven inches in length; while, so far as the Committee is aware, no spark over three inches has ever been obtained, either by Rhumkorff or his English improver, Hearder, until after an instrument constructed by Mr. Ritchie on this plan had been sent to England; and even now a spark of the same length from one of those instruments requires much larger batteries than those of Mr. Ritchie.

The Committee regard the modifications which Mr. Ritchie has introduced into the apparatus as improvements, and his mode of winding the coil, especially, as novel, ingenious, and highly valuable; and believing that this apparatus is destined to be of great importance in the arts, owing to the economy, simplicity, and energy with which it generates a powerful electric current; and regarding some of the modifications of Mr. Ritchie to be original and of great utility, they recommend the award of the *Scott's Legacy Medal and Premium* to Mr. E. S. Ritchie, of Boston, for his Improved Rhumkorff's Induction Apparatus.

By order of the Committee,

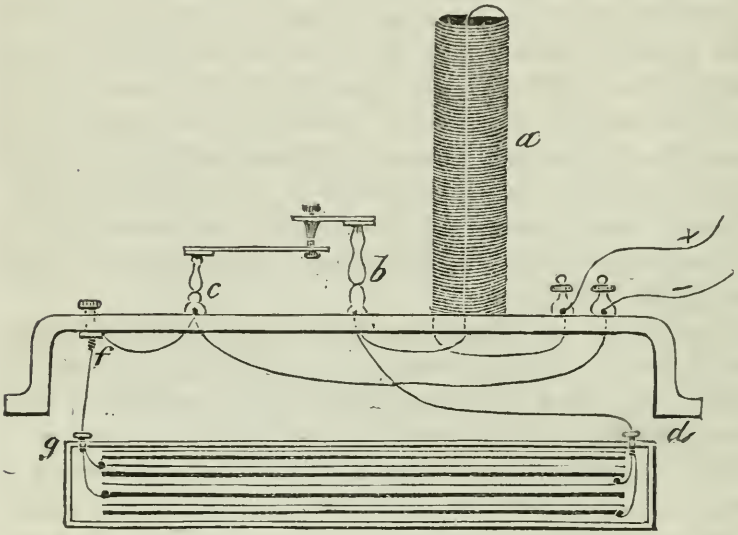
WM. HAMILTON, *Actuary.*

Philadelphia, May 10th, 1860.

Description of Ritchie's Rhumkorff's Induction Apparatus.

The primary helix is made of No. 9 copper wire, which is about $\frac{1}{7}$th of an inch in diameter, insulated, and wound in three courses; its length is about 180 feet, and it encloses a bundle of carefully annealed iron wire of about 1½ inches in diameter. Wires are used instead of a solid bar as they can be more readily and perfectly annealed. One end of the wire of the primary helix passes directly to a pole cup for connecting with the battery; the other end of the wire connects with the pillar, *b*, carrying a screw capped with platinum. This is in contact with a similar platinum cap on a spring, supported upon a pillar, *c*. This pillar connects with the other pole cup. When the battery is attached, the iron bundle or core becomes a powerful electro-magnet, but is demagnetized by breaking the circuit, by depressing the spring, separating the platinum caps. This is called the "interrupter," or "break-piece." The hammer and ratchet wheel are to effect this interruption at pleasure. Over this primary is placed for insulation a bell glass, and over the bell glass is placed the

Secondary helix.—This is made of insulated copper wire of one-eightieth of an inch diameter, covered with silk, and of about sixteen miles in length. The terminals are conducted for convenience to glass pillars furnished with discharging rods.



+ and — Battery Wires.

a, Primary Helix One wire connects with + pole; the other passes to pillar (*b*) The circuit is completed through pillar (*c*) to the other pole cup.

b connects directly with knob of condenser, by a wire, at (*d*).

c connects through screw *f* with knob of condenser; or three screws at *f* bear upon 3 knobs (*g*), which each has a separate bundle of condensers. The alternate sheets of all are united at the opposite pole at *d*.

Thus far the instrument is in principle the same that has been in use for years, though incapable of throwing a spark in the air across an interval. But connected with the interruptor is a

Condenser, due to Fizeau. This is simply a Leyden jar of great surface, and is made of oiled silk with coatings of tin foil. The silk is in sheets, about 18 by 10 inches, piled up with intervening sheets of foil, a little smaller in size. Every other sheet of foil is connected by a small ribbon of foil, extending out on one side, while the alternate sheets of foil are similarly connected by ribbons, extending on the opposite side. The whole pile is enclosed for convenience in a box, and placed within the basement. The two bundles of ribbons of foil, connect with two pieces of metal coming through the cover of the box; the whole may be considered as a battery of Leyden jars, and these metallic pieces are the discharging knobs. When the box is in place, these knobs connect with the two pillars above mentioned; so that each cap of platinum of the interrupter is in metallic connexion, the one with one side of the Leyden jar, the other cap with the opposite side of the Leyden jar.

On the opposite page is a drawing which will show the connexions.

I will now give the particulars in which my instrument differs from those previously constructed.

I use a primary helix of larger proportionate diameter and of larger wire. The iron core I make much longer than either the primary or secondary helix (these are of equal length); the core I make from 50 to 100 per cent. longer. The intensity of an electro-magnet being greatest at the middle, I thus obtain a more intense magnetic force, and the intensity and volume of the induced current is much increased.

I insulate the two helices much more perfectly. Glass tubes have been used, but as the discharges took place through the iron core, I closed one end, making the tube into a bell glass, and still further added to its effect by making a flanch project from the lower edge.

In all previously constructed instruments, the secondary helix was wound longitudinally as a spool of thread, each course or stratum being insulated from the next by gutta percha or other material; but after many courses are thus laid, the intensity becomes sufficient for the spark to break through or pass around from the outer to the inner stratum, and consequently the limits of power were soon reached, and the longest spark obtained was not over three inches. Rhumkorff had hen obtained but about half an inch with a single instrument. Much greater intensity in this form is impossible, as each insulation must be ncreased proportionately in thickness, and this would carry the outer strata beyond the influence of the iron core. I devised a mode of winding the helix which obviated this difficulty. I wind my helix in strata perpendicular to the helix, and wind it as a sailor coils a rope upon the deck: beginning with a small circle, he winds arounds this his rope until the circle is as large as desirable; he lays a turn upon this last one, and commences a second stratum or layer, winding now each turn within the last, until he reaches the size of circle he commenced with; again, a third stratum upon this.

I build my coil in the same manner. I make a cylinder of gutta percha, with a flanch or head as large in diameter as the coil is to be. Each stratum is parallel with the head and between each is an insulation; but as I now only desire to prevent the spark from leaping from the wire where one layer is commenced to the wire where the next ies upon it (and the length is but a few hundred feet), a very thin nsulation is enough, and a disc of oiled silk is sufficient. The helix can be built up indefinitely, as I make the section no deeper than that the intensity obtained in each stratum equals its thickness with the thickness of insulation. Consequently, if the spark cannot leap further than from layer No. 1 to No. 2, it cannot leap to the 3d, or the 10th, or the 100th, because the *distance* from the 1st to the 3d and

10th, &c., is proportionately greater—when wound longitudinally it is otherwise. A sufficient insulation may protect No. 1 from No. 2 course, but No. 10 has ten times the intensity, and is necessarily brought very near No. 1, and the insulation fails. In this case the coil is ruined. But, as I wind it, if battery force is put on enough to make the spark leap its entire length, it does no harm.

I also cover the helix outside, sometimes entirely and sometimes only the lower portion, with gutta percha.

In previously-constructed instruments, the interrupter used was De La Rive's automatic break-piece. I found this far too rapid, that *time* was required, and that for different results a very varied rate is requisite; also, that a *sudden* break is more effective. I devised the interrupter to meet these requirements, and place the discharges more in control of the operator. By my interrupter, a longer and a far more voluminous discharge is produced.

I divide the condenser into two or three parts, and connect each through a screw, so that either or all may be used, or all may be disconnected.

To introduce these changes, of course the entire form and arrangement of parts are different from all others.

So far as I have information, not until after I had published my mode of constructing this instrument and had sent one to the order of Gassiot, of London, throwing over twelve inches, had any been made of over three inches of spark.

I respectfully submit the instrument with these explanations to the Committee on Science and the Arts of the Franklin Institute.

E. S. Ritchie.

Boston, Dec. 10, 1858.

METEOROLOGY.

For the Journal of the Franklin Institute.

The Meteorology of Philadelphia. By James A. Kirkpatrick, A. M.

May.—The month of May, 1860, was distinguished for its thunder storms, and the number of days on which rain fell. There were no less than eight thunder storms at Philadelphia during the month, though but little damage resulted from them here. Those of the 21st and 30th of the month, however, were very violent and destructive; the former in Ohio, and the latter in the north-western part of Pennsylvania.

Rain fell at Philadelphia on nineteen days of the thirty-one, showing a greater number of rainy days than has ever before been noticed in the month of May. In May, 1858, rain fell on eighteen days, and in 1853 and 1854, on fifteen days. The average number of rainy days for the month of May, during nine years, is thirteen.

The mean temperature of the month was less than 1° above the average, while it was about half a degree colder than May, 1859.

The warmest day of the month was the 25th, of which the average temperature was 74·3°. The 7th, however, was almost as warm, having an average temperature of 74·0°. The thermometer was highest on the 7th, reaching 90° about 2½ P. M. The thermometer was lowest on the morning of the 1st, when it indicated 44°. The 1st was also the coldest day, the average temperature being 47·7°.

The barometer was highest (30·050) on the 12th, and lowest (29·479) on the 19th of the month. There was a period of low barometer, extending from the 17th till the 24th, reaching the minimum about 4 P. M. on the 19th, a day or so before the storm so destructive to life and property occurred in the west. A similar, though less marked fall in the barometer occurred on the 30th and the 31st of the month.

An inspection of the following table will show another illustration of the fact alluded to in the *Journal* for the last month in relation to the close coincidence of the average barometric height for the month, with that for 9 P. M. During last May the average height for 9 P. M. was but ·005 of an inch higher than the average for the month. During the month of May, 1859, it was but ·002 of an inch higher; and for the same month, for nine years, it stood only ·003 of an inch higher at 9 P. M. than the monthly average for the same period.

A Comparison of some of the Meteorological Phenomena of May, 1860, *with those of May,* 1859, *and of the same month for nine years, at Philadelphia.*

	May, 1860.	May, 1859.	May, 9 years.
Thermometer.—Highest,	90°	87°	90°
“ Lowest,	44	44	35
“ Daily oscillation,	17·20	19·70	16·60
“ Mean daily range,	5·20	5·70	5·60
“ Means at 7 A. M.,	59·66	59·66	58·47
“ “ 2 P. M.,	71·03	72·24	69·79
“ “ 9 P. M.,	61·57	62 06	61.61
“ “ for the month,	64·09	64·65	63·29
Barometer.—Highest,	30·050 in.	30·176 in.	30·338 in.
“ Lowest,	29·479	29·512	29·386
“ Mean daily range,	·100	·111	·121
“ Means at 7 A. M.,	29·828	29·894	29·843
“ “ 2 P. M.,	29·787	29 853	29 809
“ “ 9 P. M.,	29·815	29·876	29 830
“ “ for the month,	29·810	29·874	29·827
Force of Vapor—Means at 7 A. M.	·395 in.	·361 in.	·361 in.
“ “ “ 2 P. M.	·421	·383	·383
“ “ “ 9 P. M.	·420	·393	·383
Relative Humidity at 7 A. M.	76 per ct.	70 per ct.	73 per ct.
“ “ 2 P. M.	57	50	53
“ “ 9 P. M.	76	69	69
Rain, amount in inches,	3·589	1·946	4·196
Number of days on which rain fell,	19	11	13
Prevailing winds,	N. 59°2′ E.·070	S.7°36′ W. ·090	N71°12′ W·099

The amount of rain which fell during the month was nearly twice as much as that which fell in May, 1859, but is still below the average for nine years. The force of vapor and the relative humidity, as will be seen by an inspection of the table, were both considerably higher than usual.

SPRING.—The Spring, consisting of the months of March, April, and May, was one degree warmer than the average for the last nine years, but a degree and a half cooler than the Spring of 1859.

The barometric observations are almost the same as those for the Spring for nine years, but are considerably higher than for the Spring of 1859. The closeness of the 9 P. M. observations to those for the quarter, are also very apparent in the following table of comparisons.

The number of days on which rain fell was more than the average, although the amount of rain and melted snow which actually fell was three inches less than the average, and four and a half inches less than fell during the Spring months of last year.

A Comparison of the SPRING *of* 1860, *with that of* 1859, *and of the same season for nine years, at Philadelphia.*

	Spring, 1860.	Spring, 1859.	Spring for 9 years.
Thermometer.—Highest, . . .	90°	87°	90°
" Lowest, . .	25	20	4
" Daily oscillation, .	18·10	17·40	15·90
" Mean daily range, .	6·00	6·00	6·07
" Means at 7 A. M., .	47·26	49·04	46·59
" " 2 P. M., .	59·98	61·23	58·19
" " 9 P. M., .	51·07	52·78	50·54
" " for the spring,	52·77	54·35	51·77
Barometer.—Highest, . . .	30·303 in.	30·360 in.	30·522 in.
" Lowest, . . .	29·319	29·215	28·884
" Mean daily range, . .	·133	·174	·164
" Means at 7 A. M., .	29·835	29·798	29·829
" " 2 P. M., . .	29·779	29·755	29·785
" " 9 P. M., .	29·813	29·780	29·813
" for the spring, .	29·809	29·778	29·809
Force of Vapor—Means at 7 A. M.	·259 in.	·258 in.	·253 in.
" " " 2 P. M. .	·277	·274	·273
" " " 9 P. M.	·277	·280	·273
Relative Humidity—Means at 7 A. M.	73 per ct.	69 per ct.	73 per ct.
" " " 2 P. M.	50	49	53
" " " 9 P. M.	68	66	68
Rain and melted snow, . . .	8·558 in.	14·117	11·727
No. of days on which rain or snow fell,	42	38	37
Prevailing winds, ...	N.76°26′W·119	S.76°32′W.·148	N.73°32′W·198

Abstract of Meteorological Observations for April, 1860; *made in Philadelphia, Franklin, Indiana, and Armstrong Counties, Pennsylvania, for the Committee on Meteorology of the Franklin Institute.*

1860.	PHILADELPHIA.—Lat. 39° 57′ 28″ N. Long. 75° 10′ 28″ W. Height above the sea 50 feet. Prof. J. A. KIRKPATRICK, Observer.									CHAMBERSBURG, Franklin Co. Lat. 39° 58′ N. Long. 77° 45′ W. Height 618 ft. WM. HEYSER, Jr., Obs.							INDIANA, Indiana Co. 40° 40′ N. 79° 10′ W. Height, 1321 ft. W. B. HILDEBRAND, Obs.			FREEPORT. Armstrong Co. 40° 44′ N. 79° 42′ W. Height, 1000 feet. J. H. BAIRD, Obs.		
	Barometer.		Thermometer.			Force of vapor.	Relative humidity.	Rain.	Prevail'g winds.	Barom	Thermom.		Force of vapor.	Relative humidity.	Rain.	Prevail'g winds.	Thermometer.		Prevail'g winds.	Thermometer.		Prevailing winds.
April.	Mean.	Mean daily range	Mean.	Daily oscillation.	Mean daily range.	2 P.M.	2 P. M.			Mean.	Mean.	Mean daily range.	2 P. M.	2 P. M.			Mean.	Mean daily range.		Mean.	Mean daily range.	
	Inch.	Inch.	°	°	°	Inch.	Per ct.	Inches.	Direc.	Inch.	°	°	Inch.	Per ct.	Inch.	Direc.	°	°	Direc.	°	°	Direc.
1	29·391	·224	55·0	23	7·5	·239	39	0·078	S W.	28·834	48·3	10·0	·309	64	0·180	W.	31·7	22·0	N W.	39·0		(var.)
2	29·675	·284	35·7	14	19·3	·081	31		N W.	29·169	34·0	14·3	·093	41		W.	46·0	14·3	(var.)	28·7	10·3	N E.
3	29·684	·111	43·3	25	8·3	·132	34		S.	29·052	45·7	11·7	·116	36		(var.)	50·7	5·7	(var.)	47·3	18·7	?
4	29·466	·218	55·3	16	12·0	·394	76	0·083	S.	28·851	49·7	6·0	·362	87	0·265	(var.)	42·3	8·3	S W.	50·0	7·3	S W.
○ 5	29·560	·109	54·3	21	5·0	·142	22	0·145	S W.	29·001	53·7	8·0	·150	85		W.	47·3	6·3	N W.	45·0	5·7	(var.)
6	29·781	·221	49·3	16	5·0	·173	36		N W.	29·330	48·3	5·3	·157	38		W.	52·0	11·3	S E.	40·0	5·0	W.
7	30·035	·254	46·8	21	2·5	·161	35		(var.)	29·440	51·3	5·7	·163	28		S W.	60·3	8·3	S W.	53·3	13·3	N E.
8	29·776	·258	54·7	21	7·8	·472	88	0·387	S W.	29·182	55·7	4·3	·238	65	0·526	E.	64·7	7·0	S E.	64·0	10·7	W.
9	29·690	·097	57·7	12	3·0	·500	88	0·645	N N E.	29·184	57·0	11·3	·476	70	0·068	(var.)	58 7	6·0	S E.	62·0	6·7	N E.
10	29·880	·189	45·0	13	12·7	·261	84	} 1·216	E.	29·372	49·7	7·3	·269	67	1·400	E.	43·0	15·7	(var.)	63·3	3·3	S W.
11	29·712	·200	45·3	10	3·0	·282	78		N W.	29·236	51·0	5·3	·236	70	1·305	W.	44·7	11·0	N W.	41·3	22·0	(var.)
☾ 12	29 894	·184	40·8	23	5·5	·172	33	0·003	W N W	29 416	50·3	2·7	·203	42		(var.)	40·7	4·7	W.	46·7	9·3	S W.
13	29·808	·090	50·0	16	3·5	·150	33		W S W.	29·376	47·0	4·0	·110	26		W.	36·3	10·3	N W.	43·3	3·3	(var.)
14	29·798	·060	41 3	22	8·7	·198	74	0·030	S W.	29·315	44·0	4·3	·125	40		W.	39·0	14·7	E N E.	37·3	8·0	(var.)
15	30·071	·273	39·8	18	6·8	·113	38		N W.	29·530	42·0	3·3	·099	29		W.	52·0	13·0	E.	38·0	9·3	N E.
16	29·978	·098	41·7	10	3·2	·254	91	0·450	N E.	29 383	53·7	11·7	·260	78		W.				52·0	14·0	(var.)
17	29·797	·180	60·7	33	19·0	·493	59		S W.	29·345	54 0	14·3	·256	30	0·102	W.				55·7	15·7	W.
18	30·282	·484	48·7	22	12·0	·128	31		N N W.	29·807	46·7	9·3	·157	38		W.	55·0		(var.)	46·3	14·0	(var.)
19	30·193	·111	51·3	25	2·7	·197	35	0·060	S W.	29·673	54·3	7·7	·191	41		W.	52·3	10·7	S E.	55·7	9·3	(var.)
20	29·830	·363	54·7	12	6·7	·377	81	0·067	S W.	29·296	65·3	6·3	·416	57		E.	66·0	13·7	S W.	65·0	9·3	S W.
● 21	29·618	·212	62·7	33	12·7	·481	47		(var.)	29·096	64·3	15·7	·452	44	0·056	W.	66·7	2·0	(var.)	63·7	4·3	(var.)
22	29·716	·098	44·0	10	18·7	·223	69	0·422	N E.	29·154	52·7	15·0	·295	68		(var.)	56·7	10·0	N W.	53·3	10·0	N W.
23	29·737	·041	51·8	15	7·8	·279	62		W S W.	29·224	52·0	2·7	·229	44		W.	45·3	11·3	N W.	43·7	9·7	N W.
24	29·766	·046	47·8	15	4·0	·150	33		N W.	29·286	43·3	8 7	·118	25		W.	39·0	6·3	N W.	37·7	6·0	(var.)
25	29·716	·050	42·5	18	5·3	·220	63	0·060	W S W.	29·194	43·3	4·0	·125	40		W.	35·3	3·7	N W.	36·7	2·7	W.
26	29·863	·147	44·7	23	4 8	·118	29		W N W	29·420	44·7	4·0	.091	23		W.	34·0	4·7	N W.	37·3	5·0	(var.)
27	30·044	·180	49·5	23	4·8	·161	35		(var.)	29·554	49·3	6·0	·129	27		(var.)	41·7	7·7	N W.			?
☽ 28	30·073	·045	52·8	17	3·3	·185	37		(var.)	29·543	51·7	4·7	·204	45	0·065	W.	49·3	7·7	S E.	51·7		?
29	29·976	·097	53·7	17	3 5	·119	21		S E.	29·441	56·7	5 0	·176	30		E.	54·3	5·0	E.	57·7	6·0	N E.
30	29 925	·051	54·5	23	2·8	·163	27		N N E.	29·417	52·7	4·0	·150	23		E.	66 7	9·0	S E.	60·3	4·0	S W.
Means	29·824	·166	49·5	19	7·4	·234	50	3·646	N88¼W.	29·293	50·5	7·5	·215	45	3·967	West.	49·0	9·3	N70°W.	48·8	8·3	N62¼°W.

Abstract of Meteorological Observations for April, 1860; *made in Adams, Dauphin, Northumberland, Centre, and Somerset Counties, Pennsylvania, for the Committee on Meteorology of the Franklin Institute.*

1860.	Gettysburg, Adams Co. Lat. 39° 49′ N. Long. 77° 18′ W. Height 624 ft. Prof. M. Jacobs, Obs.					Harrisburg, Dauphin Co. 40°16′, N. 76°50′, W. Ht., 300 ft. John Heisely, M.D., Obs.					Shamokin, Northumberland. Co. 40° 45′ N. 76° 30′ W. Height, 700 ft. P. Friel, Obs.				Fleming, Centre Co. 40° 55′ N. 77° 53′ W. Height, 780 feet. S. Brugger, Obs.				Somerset, Somerset Co. Lat. 40° N. Long. 79° 3′ W. Height 2195 feet. Geo. Mowry, Observer.						
April.	Barom Mean.	Thermom. Mean.	Thermom. Mean daily range.	Rain.	Prevail'g winds.	Barom Mean.	Thermom. Mean.	Thermom. Mean daily range.	Rain and Snow.	Prevail'g winds.	Thermom. Mean.	Thermom. Mean daily range.	Rain and Snow.	Prevail'g winds.	Thermom. Mean.	Thermom. Mean daily range.	Rain and Snow.	Prevailing winds.	Barom Mean.	Thermom. Mean.	Thermom. Mean daily range.	Force of vapor. 2 P.M.	Relative humidity. 2 P.M.	Rain and Snow.	Prevail'g winds.
	Inch.	°	°	Inch.	Direc.	Inch.	°	°	Inch.	Direc.	°	°	Inch.	Direc.	°	°	Inch.	Direc.	Inch.	°	°	Inch.	Per ct.	Inch.	Direc.
1	28·964	45·7	11·0	0·150	(var.)	29·2[illegible]7	50·0	10·7		S W.	44·3	10·3	0·400	(var.)	43·0	19·0	0·600	S E.	27·206	45·0	11·7	·295	79	0·360	(var.)
2	29·278	31·3	14·3		N.	29·561	37·0	13·0		N W.	30·0	14·3		W.	32·3	12·0		N W.	27·431	23 7	16·3	·101	50		(var.)
3	29·201	44·3	13 0	0·050	N E.	29·482	45·3	8·3		S W.	40·7	10·7		W.	43·0	10·7	0·180	S E.	27·279	45·3	10·0	·295	59	0·042	S W.
4	28·931	48·3	7·0	0·150	S S W.	29·205	52·7	6·7	0·135	N E.	46 3	5·7		S E.	46·3	3 3	0·130	(var.)	27·133	45·3	8·3	·318	96	0·645	(var.)
○ 5	29·178	50·7	7·3		S W.	29·379	53·0	1·0	0·158	S W.	44·7	1·7		W.	46·0	6·3		W.	27·315	41·7	6·7	·196	52	0·195	W.
6	29·477	45·3	5·3		N W.	29·719	48·7	4·3		N W.	43·3	8 0		W.	41·7	4·3		W.	27·623	39·7	2·7	·208	66		WNW
7	29·630	46·7	6·7		S.	29·885	49·7	5·0		S E.	40·0	6·7		W.	48·0	13·0		(var.)	27·667	46·7	8·3	·288	61		S S E.
8	29·337	51·3	6·7	0·400	S.	29·616	50·7	5·7	} 1·554	(var.)	48·3	12·3	0·500	(var.)	50·0	7·3	0·340	W.	27·474	60·7	14·0	·463	51	0·346	W.
9	29·325	59·3	8·0	0·075	N N E.	29·581	60·0	9·3		N E.	56·3	8·0	0·436	E.	58·3	8·3	0·400	(var.)	27·511	60 3	7 7	·577	84	1·833	S.
10	29·481	46·3	13·0	} 2·725	N E.	29 746	47·7	12·3	} 1·391	E.	44·3	12·0	0·348	E.	49·3	9·0	1·380	(var.)	27·534	52·0	8·3	·375	93	} 1·887	S S E.
11	29·355	43·3	3·0		N E.	29·600	46·0	1·7		N.	42·3	2·0	0·600	(var.)	44·0	5·3	0·620	(var.)	27·579	41·3	10·7	·250	95		N W.
☾ 12	29·543	47·7	9·0		S W.	29·798	50·3	8·3		S W.	42·7	11·0	0 035	N.	44·7	8·7	0·200	(var.)	27·675	45·3	12·0	·295	59	0·230	W.
13	29·482	50·3	5·3		N N W.	29·750	52·0	4·3		N W.	43·0	11·7	0·100	W.	43·3	8·0	0·085	N W.	27·690	43·0	6·3	·188	56		WNW
14	29·384	42·7	7·7		N W.	29·683	44·7	7·3		(var.)	34·3	6·0	0·200	W.	39·3	8·0	0·140	N W.	27·615	37·3	9·0	234	91	0·064	N W.
15	29·698	38·7	6·3		(var.)	29 983	40·7	4·7		N.	34·0	10·3		W.	36 0	10·0		E.	27·755	37·3	13·7	·188	56		(var.)
16	29·477	42·7	6·3	0·060	S S W.	29·845	42·0	3·3	0·074	E.	40·0	6·0	0·232	E.	40·0	8·0	0·315	W.	27·602	52·0	14·7	·391	87	0·110	S W.
17	29·461	59·7	17·0		WNW					(var.)	58·7	18·3		W.	55·7	15·7		N W.	27·692	58·7	17·3	·366	52		W.
18	29·950	45·3	14·3		N N W.	30·211	49·3			N W.	50 3	8·0		W.	43·3	12·3		(var.)	28·014	44·7	14·0	·217	50		(var.)
19	29·806	48·3	3·7		(var.)	30·099	59·3	2·7		(var.)	46·7	6·3		S W.	48·0	8·7		S E.	27·867	46·0	4·0	·245	65		S.
20	29·462	59·3	11·0		S W.	29·711	57·3	6·0		S W.	57·7	11·0	0·150	S.	56·7	8·7	0·360	W.	27 654	62·7	16·7	·531	63	0·039	W.
● 21	29·382	73·3	14·0	0·255	(var.)	29·506	65·3	8·0	0·512	(var.)	62·3	4·7	0·533	N W.	64·7	8·0	0 730	W.	27 497	62·3	7·0	·489	74		W.
22	29·293	48·7	24·7		N E.	29·578	47·3	18·0		N E.	41·7	20·7	0·100	S E.	51·0	13·7	0·300	(var.)	27·485	59·7	3·3	·443	65		W.
23	29 354	51·2	2·5		W S W.	29 627	51·0	3·7		(var.)	47·3	5·7		E.	48·0	4·3	0·140	N W.	27·573	46·0	13·7	·308	79		W.
24	29·397	45·0	6·2		N W.	29·659	48·0	3·0		N W.	43·3	4·0		(var.)	40·0	10·0		N W.	27·573	37·3	8·7	·195	68		WNW
25	29·322	40·0	5·0		N W.	29·598	41·7	6·3		N W.	32·7	10·7	0·203	S.	36·0	4·0	0·050	N W.	27·513	32·7	5·3	·147	78	0·032	WNW
26	29·545	41·3	2·7		N W.	29·798	45·3	5·7		N W.	39·3	7·3		N W.	35·3	3·3		N W.	27·705	34·7	3·3	·132	53		WNW
27	29·687	48·7	7·3		S W.	29·965	49·0	3 7		W.	30·7	4·0		N W.	43·3	8·0		N W.	27·813	42·0	7·3	·230	55		W.
☽ 28	29·693	46·0	4·0	0·070	(var.)	29·976	50·7	2·3		S E.	44·7	4·0		E.	47·7	6·3		S E.	27·772	47·7	5·7	·268	58		S E.
29	29·531	52·7	6·7		N E.	29·851	56·3	5·7		N E.	52·3	7 7	0·311	E.	51·0	7·3		W.	27·706	52 3	4·7	·255	46		E.
30	29·542	53·7	2·3		N E.	29·829	55·0	3·3		E.	48·0	7·7		(var.)	49·0	4·0		W.	27·677	50·7	4·3	·222	37		S.
Means	29·439	48·3	8·4	3·935	N67°W.	29·706	49·9	6·9	3·824	N14¼W.	43·1	8·6	4·148	S72¼W.	45·8	8·5	5·960	N58°W.	27·588	46·7	9·2	·290	66	5·783	West.

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CIVIL ENGINEERING.

*n Coal-burning and Feed-water Heating in Locomotive Engines.**

By Mr. D. K. Clark, Assoc. Inst. C. E.

The object of the paper was stated to be, to discuss and compare e existing practice of coal-burning on railways. In burning coal, was necessary to introduce air, in such quantity as to maintain a fficiently high temperature in the furnace, and so to distribute it nongst the solid and the gaseous portions of the fuel, as to effect e thorough mixture of the air and the gases. After noticing the sufficiency of the ordinary locomotive boiler in its normal condition r the proper combustion of coal, the author described the methods troduced within the last two years for admitting air above the fuel, nongst the combustible gases. They were classed as—first, acting y currents of air, introduced through tubular or other openings in e sides of the fire-box, uniformly distributed over the surface of the el; secondly, by deflection of a body of air, introduced through the oorway, or elsewhere, upon and over the surface of the fuel; and, irdly, by constructing large and spacious fire-boxes, with large rates and long runs. The third class, which was first in chronoloical order, was represented by the systems of Mr. M'Connell, Mr. eattie, and Mr. Cudworth. Of these, the first and second were made ith combustion chambers projected into the barrel of the boiler, and e second had, in addition, transverse midfeathers, and brick arches nd tiles, for the better mixture of the elements, and the maintenance f the temperature; whilst the third consisted of an elongated fire-box, with an inclined fire-grate sloping towards the tube-plate. In the application of the first and second classes of smoke-burners, the problem resolved itself into the following conditions:—The immediate and thorough intermixture of a plentiful but regulated supply of air, with the ascending smoke or combustible gases at or near to the surface of the fuel. Practically, it was found necessary for this object to operate from both the front and the back of the fire-box, with air-entrances, arches, and deflectors at the doorway, in various combinations. But such contrivances as dealt with air in bulk, though generally effective in preventing smoke, were stated to be usually attended by the escape of a considerable quantity of unconsumed air, through the flue-tubes, and a difficulty in keeping up steam at high speeds. The various forms of doorway deflectors were also stated to be objectionable, in facilitating, by their mode of action, the suction of particles of coal through the tubes, and the burning of the smoke-box, unless counteracted by an internal arch. The author had found by experience, that to burn smoke when the engine was working, it was sufficient that the air should be admitted at or near the surface of the fuel, by air-tubes distributed over the width of the fire-box, in the front and the back, without the aid of internal arches or deflectors. The draft of air through the front tubes was very strong when the engines ran ahead, carrying the currents into the middle of the fire-box, where they met the counter-currents from the back, effecting the mixture of the air and smoke, and preventing the suction of small coal through the tubes. But, in all systems applied to ordinary fire-boxes operating by means of the draft available in a locomotive engine, aided, when the blast was off, by the steam-jet in the chimney, range of power was wanting to overtake the extremes of intense ignition and rapid generation of smoke-making gases, immediately after the steam was shut off, or when fresh fuel was added; and to suit itself, also, to the quiet state of the fire, when the glow and excitement subsided, as well as to all the varying conditions of a locomotive furnace. The means of extending the range, volume, and power of the air-currents, and of adjusting them to the wants of the furnace, were supplied by the instrumentality of jets of steam, employed by the author as means of inducting and accelerating currents of air. The steam-nozzles, with the air-tubes towards which they were pointed, were like so many miniature blast-pipes and chimneys turned into the fire-box; and they possessed, relatively, the same power of urging and creating draft. By this method of steam induction, the air-currents were delivered with such precision and velocity, as to sweep the whole surface of the fuel, and forcibly to distribute the air amongst the gases.

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*From Newton's London Journal, June, 1860.

In practice, it was only occasionally necessary to put the steam-jets in action when the engine was at work if the air-openings were sufficiently numerous, as the action of the blast alone drew a large supply of air through them into the fire-box. The time when the full inducting power of the jets of steam was in demand, was immediately on the steam being shut off from the engine, on drawing up to a station, or otherwise. Then, the heat in the fire-box was fierce, and there was an extensive distillation of combustible gases, which were discharged as smoke from the chimney, unless met and consumed by the inducted currents above the fuel. The intenseness of the heat subsided rapidly, and the jets could be moderated as desired, and continued in action until the engine was again in motion. The indraft of air into the fire-box could be regulated by the use of slides or dampers over the air-openings. But, by so limiting the number of air-openings, and consequently the supply of air, as to prevent any material excess of supply when the fire was in ordinary condition, the dampers might be dispensed with in practice, without prejudice to the economy of fuel.

In making a general comparison between the various methods of coal burning without smoke, there was the difficulty of the diversity of circumstances as to time, fuel, engine, and duty to contend with. The performances of several engines burning coal, on different systems, and the same or similar engines using coke, had, however, been tabulated. It thus appeared that, of the three systems of extended fire-boxes, by Mr. M'Connell, Mr. Beattie, and Mr. Cudworth, with nearly equal gross weights of engine, tender, and train—100 to 116 tons—and at about the same speed, the consumption of coal was as follows :—

			Per ton gross.
Mr. M'Connell's,	35½ lbs. Hawkesbury coal per mile,	or	·31 lb.
Mr. Beattie's (with cold water),	24 lbs. Griff & Stavely " "	or	·235 lb.
Mr. Cudworth's,	26 lbs. coking coal, "	or	·225 lb.

Of the systems of coal-burning grafted on the common fire-box, with passenger trains, comparative results were given of Mr. Douglas' with a doorway deflector on the Birkenhead Railway; Mr. Yarrow's with a brick arch and air-bars on the Scottish North-Eastern Railway; Mr. Connor's with a brick arch and door deflector on the Caledonian Railway; Mr. Frodsham's with a doorway deflector and steam roses in the fire-box, used by Mr. Sinclair on the Eastern Counties Railway; and the author's with air-tubes and steam-inducted currents, used by Mr. Cowan on the Great North of Scotland Railway. It appeared that, with eight to ten carriages, the following were the performances :—

	Gross Weight. Tons.	Gross Coal per mile. lbs.		Per ton gross. lb.	
Mr. Douglas, .	90	28·4	or	·32	Welsh.
Mr. Yarrow, .	86	25·7	or	·32	Fifeshire.
Mr. Connor, .	88	22·2	or	·26	Lanarkshire.
Mr. Frodsham,	93	23·3	or	·25	Stavely.
Mr. Clark, .	110	21·0	or	·19	Fifeshire.

Showing that, with the author's system, less coal was used with a heavier train than with any of the others. Similarly favorable comparisons were made in the working of goods engines.

The Great North of Scotland Railway, on which the author's system was in full operation, was stated to contain long gradients, severa of which varied from 1 in 100 to 1 in 150, with frequent curves; an the goods engines could take up these inclines 35 fully loaded wagons 460 tons gross train weight, at 10 miles per hour.

In conclusion, it was stated that the author's system of smokeles coal-burning was distinguished from others by its simplicity, durability efficiency, and simple management. There was no construction of an kind within the fire-box, and, consequently, no wear and tear by exposure to intense heat. At the same time that it commanded th entire range of the fire-box, it did not interfere with or impose extr labor in the management of the fire. The manipulation was simple the air-tubes being placed at a sufficiently high level to command th surface of the fire at all times. The whole business of smoke-prevention was comprised in the occasional operation of the induction-jets by means of a tap under the hand of the engine-driver, and the occasional aid of the chimney-blower, to carry off the products of combustion. By the proper use of this system, the fire might be "damped, or kept dull, when desired, where an engine had to wait at a station without raising the pressure of the steam; as the forcible indraf above the fire might be made to prevent a draft through the fire, an consequently to check or to suspend the combustion of the fuel; conducing both to safety and to economy, and favorably contrasting wit other systems, in all of which a powerful blower in the chimney wa needed, when standing, incurring dangerous pressures and waste steam.

In feed-water heaters, it was stated that little had as yet been don except by Mr. Beattie, whose apparatus, though efficient as a heate was found, it was believed, to be too complicated for general use, an difficult to keep in order. The author had recently introduced a simpl and compact heater, in which the steam from the blast-pipe was projected into a short tube, in conjunction with the feed-water, whic was delivered in a thin annular sheet around the steam-nozzle. I this short tube or chamber, the water was broken into spray by th steam; the steam was instantly condensed, and the water was raise to a high temperature, at or near the boiling point. It had give satisfactory results in a 20 H. P. stationary engine, and would shortl be applied to a locomotive engine. It was said to be well adapted fo agricultural and other engines on wheels, where lightness and compactness were considerations of importance.

In the course of the discussion upon Mr. D. K. CLARK'S pape "*On coal-burning and feed-water heating in locomotive engines*," was remarked, that the plan of coal-burning advocated by the autho seemed to be similar to that adopted by Mr. Jenkins, and which ha been some time in use on the Lancashire and Yorkshire Railwa except that in the former jets of steam were employed to accelerat the currents of air. Mr. Jenkins' system consisted simply in makin a certain number of the stays hollow instead of solid, through whic the air was allowed to pass, and, mixing with the products of combustion, effected the prevention of smoke. Movable slides were fixe on the outside, so that the apertures could be opened or closed at pleasure; and thus, either coal or coke could be burned in the same engine. The system could be applied to old engines, at an expense of a few pounds per engine, and was said to be simple and effective.

It was stated that the use of tubes through the sides, and in some cases the front, of the fire-box, for preventing smoke, had been tried nineteen years ago by Mr. Samuel Hall, the pioneer of surface-condensation, on the Midland Railway, and the same system was now practised on the Great Western Railway. The smoke, though then not entirely consumed, was believed to have been as effectually got rid of as at the present day. Formerly the defect was, that the tubes were burned; but where coal could be obtained at much less cost than coke, a want of simplicity, or the necessity of slight additional repairs, might be overlooked. When first brought forward, an objection was taken to Mr. Hall's plan, that when an engine was standing at a station, black smoke was emitted. This was remedied by the introduction of a small jet of steam in the chimney, for creating a draft when the engine was at rest; but the noise thus produced caused the plan to be laid aside.

In regard to the general question of smoke-prevention, it was argued that neither deflecting plates nor brick arches were needed; but only the introduction of a sufficient quantity of air, moderately diffused over the fuel. In 1856, the use of hollow stays and small jets of steam had been suggested by Mr. Robert Longridge, particularly for marine engine boilers, where there was a difficulty in getting the proper quantity of air through the tubes; but it was thought that, in a locomotive, the requisite quantity of air to consume the hydro-carbons might be introduced by the hollow stays, without resorting to steam jets.

As to the comparative heating powers of coal and coke, it was sometimes asserted that the same evaporative effect would be obtained from the coke made from a ton of coal, as from the original ton of coal itself. This view was dissented from, and it was stated that careful experiments with Garesfield coal and coke showed the evaporative power to be as 100 to 89, respectively, weight for weight. In other words, 1 lb. of coal evaporated 12·54 lbs. of water, whilst 1 lb. of coke evaporated only 11·16 lbs. of water. But, inasmuch as 100 tons of coal produced only 66 tons of coke, it was evident that while 1 lb. of coal would evaporate 12·54 lbs. of water, the same weight of coal, converted into coke, would only evaporate $11{\cdot}16 \times {\cdot}66 = 7{\cdot}44$ lbs. of water; so that the true proportion was as 100 to 58.

On the other hand, it was stated that, with Midland coal, 20 cwt. of coal produced $11\frac{1}{2}$ cwt. of coke, besides other products, and 6 cwt. of coke evaporated exactly the same quantity of water as 7 cwt. of coal: consequently there was a loss in converting coal into coke, for he purpose of producing steam; but considered only in reference to weight, coke had an advantage over coal in the proportion of seven o six.

It was contended that, in order to enable a proper comparison to be made between the amount of fuel used per mile and the gross load carried, the paper should have showed—1st. What was the greatest altitude surmounted in each case, the total length of the line, the ruling gradient and its length. 2d. What was the average speed per mile for the whole distance run. And, 3d. How many lbs. of water were evaporated by 1 lb. of coal.

It was observed that, in attempting the general introduction of anthracite coal in locomotive engines in the United States for long and heavy traffic, it was found that, although there was no smoke, it was difficult to keep up the steam, and the fire-box and fire-bars were quickly burnt out. Notwithstanding these objections to its use, anthracite was in some cases a cheaper fuel than wood. Anthracite coal was burned on the Reading Railroad at the rate of 120 lbs. per mile, in engines weighing 28 tons, and carrying a gross load of 750 tons, at from ten to twelve miles an hour, on a level. The evaporation of water was from 5½ lbs. to 6 lbs. only per pound of coal. A brief description was given of Phleger's, Dimpfel's, and Boardman's boilers, which had been made to burn bituminous as well as anthracite coal, and were used on passenger as well as goods trains. Each furnished considerable space for combustion, and air was admitted in numerous fine streams over the fire. They were all, however, heavy and complicated, and inapplicable to existing stock. Within the last three or four years, renewed attempts had been made to adapt the existing stock of engines to the use of bituminous coal. The difficulties consisted in the large quantity of coal required to be burned in a given time, under an intense draft, and in the clinkery character of the coal itself. The engines were not heavier, on the average, than in England, nor had they more heating surface; but they burned more fuel and evaporated one-fourth more water in a given time. In December, 1856, Mr. G. S. Griggs, of the Boston and Providence Railroad, introduced a fire-brick arch, below the tubes, in the fire-boxes of some of the engines of that line. With a few holes for the admission of air above the fire, this arch was found to improve the working of the fire-box, when burning coal. On the Iowa Central Railroad, the grates of the coal-burning engines were at one time covered with fire-brick, so as to leave only about two square feet of the original surface of the bars exposed; and of this area, less than one square foot was air-opening. More recently, perforated door-plates and air-distributors (the latter set up within the fire-box) had been extensively adopted.

It was stated, in reply to the observations which had been made, that in a comparative trial of the author's system and Mr. Jenkins', on a metropolitan railway, on the same passenger engine, and on the same duty, the former consumed 4 lbs. per mile, or 12 per cent., less coal than the latter; that the saving of coal by smoke-prevention in locomotives had been found to be at least 18 per cent.; that the information demanded, for the purpose of making a proper comparison, was given in the paper; that it was of no use to state altitudes simply, unless particulars of inclines and length of trip were also given.—*Proc. Inst. Civ. Eng., May* 1–8, 1860.

*On Combined Steam.** By the Hon. John Wethered, U. S.

It was stated that at the present day the great desideratum in marine engines appeared to be, to obtain increased power or economy in the consumption of fuel, without the commercial disadvantage of occupying more space by the enlargement of the boilers and machinery. This object it was believed had been attained by the application of ordinary and superheated steam mixed. The mode adopted in carrying out this system was, to attach another steam pipe to the boiler, for conveying the steam to be superheated to pipes or other contrivances placed in any convenient form near the fire, or in the uptake or chimney of the boiler, or in a separate furnace; the superheated steam being added to the ordinary steam at or before its entrance into the cylinder. In its passage through the superheating apparatus, that portion of the steam was raised by the waste heat to a temperature of 500° or 600° F. The heat thus arrested was conveyed to and utilized in the cylinder, by its action on the other portion of steam from the boiler, which was more or less saturated according to circumstances. The combined steam was used in the cylinder at from 300° to 450° F., instead of at the low temperature at which steam was generally employed. The effect of using the two kinds of steam was, that the superheated steam yielded a portion of its excess of temperature to the ordinary steam, converting the vesicular water which it always contained into steam, and expanding it several hundred-fold; whilst at the same time, the ordinary steam yielded a portion of its excess of moisture, converting the steam gas into a highly rarefied elastic vapor—in other words, into pure steam at a high temperature.

It was asserted, that repeated endeavors had been made in England, France, and America, to employ steam simply dried, or superheated, and as often abandoned. This plan certainly resulted in partial economy; but owing to the high degree of temperature necessary in this case, the lubricating materials were dried up, and then the packing and rubbing parts of the machinery were destroyed. Moreover, when all the steam was superheated the temperature of the steam in the cylinder was beyond the control of the engineer. It was this difficulty which had led to the discovery of the system of employing mixed steam, which was entirely under control; for by merely turning a valve it could be so regulated as to produce the highest mechanical effect, with the most perfect lubrication to the slides and cylinders. Another advantage was, that if any accident should happen to the superheating apparatus, the cylinders could still be supplied with plain steam alone.

A series of trials on board the R. M. S. S. *Avon* had shown that the pressure in the boiler being in all cases the same, with plain steam the result was 1070 I. H. P.; with the steam from three boilers superheated and from the fourth plain it was 1076 I. H. P.; while with the steam mixed in the proportions of 61 superheated and 69 plain, 1200 I. H. P. was produced. The Lords of the Admiralty were stated to be so well satisfied with the results of experiments continued over twenty voyages, that they had determined to extend the application of the system in the Royal Navy, and H. M. S. S. *Rhadamanthus* had been ordered to be fitted with it. Mr. A. C. Hobbs (Assoc. Inst. C. E.) had applied it to a high pressure boiler and engine, and Mr. Dorman had adapted it to an engine which did not produce the required power. The combined steam was also used in all the steamers of the Collins line. Experiments on board the *Gibraltar* showed that superheated steam at a pressure on the boiler of 10 lbs. produced 222 I. H. P.; ordinary steam at 14 lbs. pressure, 307 I. H. P.; while combined steam at 15 lbs. pressure gave 376 I. H. P.

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* From the London Civ. Eng. and Arch. Jour., May, 1860.

When steam was merely superheated or dried, it was converted into steam gas. It consequently partook of the nature of gas; was a bad conductor of heat, and gave out with difficulty the heat necessary to transform it into mechanical power. On the other hand, mixed steam participated in the qualities of steam proper and of superheated steam, and being a pure highly rarefied vapor, which readily parted with its heat, thus produced greater mechanical effect.

By the application of combined steam the following advantages, among others, were said to be obtained:—1. An economy of fuel of from 30 to 50 per cent. 2. A diminution of one-third in the feed-water. 3. The employment of smaller boilers to produce the same power. 4. Facility of maintaining any desired pressure, or of increasing it at will in cases of emergency. 5. A steamer would make a voyage one-third further with the same weight of coals; or one-third the space now occupied by the fuel might be used for freight. 6. Less risk of explosion. 7. Boilers would last one-third longer. 8. A better vacuum was obtained. And, 9. One-third less injection water was required.

April 3.—The entire evening was occupied by the discussion of the preceding paper "*On Combined Steam.*"

In commencing the discussion it was remarked that the indicator cards taken from H. M. S. S. *Dee*, when using simple superheated steam and when working with combined steam, the pressure being the same in both cases and the supply valves equal in area, showed that a better vacuum was obtained and that the expansive force was much greater when using combined steam. It had been ascertained that the consumption of fuel was 2·57 lbs. per I. H. P. per hour with combined steam, whilst it averaged 5·53 lbs. per I. H. P. per hour with plain steam. The result of twenty experimental voyages in that vessel gave, on the combined system 500 H. P., by superheating simply 409 H. P., and with plain steam 404 H. P.

A case was also mentioned in which combined steam had been applied to a non-expansive engine, where a reduction was effected in the consumption of fuel of from 36 cwt. to 24 cwt. per week; while about one-third less water was consumed.

It was admitted that great praise was due to the author for having recalled public attention to the advantages derivable from superheating steam. But it was doubted whether the combined system possessed any peculiar merit over simple superheated steam. If the mixture were made just at the entrance to the cylinder, it was difficult to understand what difference there could be between that plan and at once heating the whole of the steam to a uniform temperature. It was questionable whether in a good expansive engine the application of a most efficient system of superheating, that completely prevented condensation, would result in a saving of more than 15 per cent. It was stated that in the early experiments in H. M. S. S. *Dee*, when superheating was tried, the steam was throttled, owing to the small size of the pipes; and that the apparent superiority of the combined system was due to the large ordinary steam pipe being in connexion with the engines in addition to the superheating pipe, and not from the fact of the steam being mixed. When a different arrangement was made, the superheating gave results quite equal to the combined system.

It was believed that with the best boilers there would be a saving of 15 per cent. by the use of superheated steam; and in one vessel, where there was an indifferent construction of boiler, there was an economy of 34 per cent. due partly to improvements in the boiler, and partly to the application of the apparatus giving more steam room. In one of the vessels belonging to the Intercolonial Royal Mail Company, to which superheating apparatus had been added, the consumption of fuel was reduced from 2986 ℔s. to 1900 ℔s. per hour on an average of four or five days' steaming between London and Milford Haven. Similarly, in one of the boats belonging to the General Steam Navigation Company, traveling between the Thames and Scotland, an average of twelve voyages previous to superheating showed a consumption of 126 tons of fuel per voyage. This was now reduced to 90 tons per voyage. The temperature in the uptake was formerly about 650°; now it had not been reduced more than 50°, but the temperature of the steam had been increased 100°.

It was remarked that the gain in using superheated steam did not arise from any physical law, but from the prevention of a loss by the use of dense steam. When the steam entered the cylinder, if there was but one degree of heat less in the cylinder, water must be formed. When the vacuum stroke was made, the deposited water, being relieved of the pressure due to its temperature, was rapidly vaporized and passed off as rarefied vapor, cooling the cylinder. On the steam entering to make the return stroke it brought the cylinder up to a temperature due to the pressure, and the stroke was made at that loss by the deposit of water over the whole interior surface of the cylinder and its adjuncts. When the condenser again came into action the same thing recurred, and so on continuously. A pressure indicator applied simultaneously with thermometers, showed that the loss of temperature without working expansively was 20°, with an average pressure of 6 ℔s., indicating a loss of steam of between one-third and one-fourth. This injurious effect must always occur when using dense steam; whereas, in employing superheated steam there was no deposit of water, and the result was analogous to that of a permanent gas, but with the advantage of easy and complete condensation. Further, when the vacuum stroke was performed, since the cylinder was perfectly dry, the exhaustion of the whole steam was effected instantaneously. With dense steam, the cylinder being wet, the deposited water had to be vaporized and condensed, thus damaging the vacuum. As this action did not occur with superheated steam, some increase of useful effect was produced on that ground. The condensing appliances were also relieved by so much as was gained in the cylinder.

It was believed that the practical limit of the use of superheated steam would be in giving it such an additional amount of caloric as would permit of its remaining dry steam to the end of its required expansion. When steam was expanded a large quantity of heat became latent. In consequence, the full effect was not obtained from expanding ordinary steam, because as it expanded in the cylinder it cooled, and there was not sufficient caloric to keep up the specific heat during the stroke.

It was observed, that the experiments on H. M. S. S. *Dee* showed a saving of 23·8 per cent. in favor of superheated over plain steam. With regard to temperature, the superheated steam lost 20° on its passage to the cylinder, 82° after entering the jacket, and 26° more after entering the cylinder; while the plain steam lost 23° only, after making its entire circuit from the boiler to the cylinder. In another experiment there was an economy of fuel of 20 per cent.; the minimum consumption at full power being 2·6 ℔s. of Welsh coal per H. P. per hour. It was thought that Mr. Wethered's system was about as economical as the superheated, when the whole of the steam was passed through the superheating apparatus. It was contended, that superheating should not be carried farther than to prevent condensation in the jacket, and therefore in the cylinder; and it was thought that the whole of the steam passing into the cylinder should go through the jacket, rather than that the jacket should be fed by small pipes.

It was pointed out that mixing ordinary saturated steam with superheated steam, gave a ready means of regulating the temperature. It was thought, that the increase of temperature should never exceed 100°. If a compensation-rod were introduced into the steam-pipe, so as to limit the admission of steam in proportion to the temperature, beneficial results might be obtained.

In reply to the observations which had been made, it was stated, that it had not been desired to advance any crude theory, but rather to narrate facts. The rationale of the principle advocated had however been given in the paper, nearly in the words of Prof. Regnault, of the French Academy. The difference between superheated and combined steam was stated to consist in this, that superheated steam being of a gaseous nature, was a bad conductor of heat, and parted with it with difficulty; whereas combined steam being pure vapor, and a better conductor of heat, parted with the heat more readily and left more heat in the cylinder of the engine, which was converted into mechanical power. The engineer-in-chief of the United States Navy had proved that there was an economy in the use of the combined steam of 52·5 per cent. over ordinary steam, and 25 per cent. over superheated steam. The experiments conducted under the authority of the Minister of Marine of France, gave nearly the same results, the figures being 52·7 and 24·0 per cent. respectively.

In the British Admiralty yacht *Black Eagle*, there had been found to be a saving of 20 per cent. in favor of the combined over the simply superheated steam.

In closing the discussion it was stated that the general opinion appeared to be, that the practical introduction of the system of superheating steam was greatly owing to the exertions of Mr. Wethered. He had succeeded in moving the British Board of Admiralty when, perhaps, an English engineer might not have been so successful; but this should be a subject of congratulation, as it was desirable at all times to give the greatest encouragement to foreigners, so as always to attract the best talent from other countries. The case did not, however, seem to be clearly established in favor of combined steam; it rested upon the facts which had been stated, and not upon any scientific explanation of the rationale of the principle, such as would account for the results claimed for it. When more than ordinary attention was given to any machine in daily use, that of itself would often lead to economy. This attention was invariably given when any new nvention was being tried, and the whole improvement, or economy, was supposed to arise from the particular modification then being tested.—*Proc. Inst. Civ. Eng., March 27th and April 3d*, 1860.

Extract from a paper "On Indian Railways; with a description of the Great Indian Peninsula Railway."[*] By Mr. JAS. J. BERKLEY, M. Inst. C. E.

The materials procurable in India for railway purposes were then succinctly noticed. In reference to the manufacture of Indian iron and the supply of coal, it was remarked that active and successful operations depended more upon the completion of railway communications, than the railways did upon a local supply of those materials. The properties of a few of the various kinds of woods which had been extensively used, were then stated. Those which had been successivey converted into sleepers were—teak, blackwood, khair, errool, and red eyne. The cost of a sleeper varied from four shillings to seven shillings and seven pence, the average price being about six shillings. Tolerably good bricks had been occasionally procured and used in arches, but in such cases a proportion of only twenty per cent. had been selected from the best native kilns. The price ranged from ten shillings to twenty-four shillings a thousand. Gunpowder cost, when made upon the spot, about £ 34 per ton.

Native labor, by which these works had been executed, was cheap, but very inferior to that of England. Nearly one hundred thousand men had been employed upon the Great Indian Peninsula Railway lines at one time, and as many as twenty thousand on the Bhore Ghaut Incline alone. The wages of the several classes per day were now—

[*] From Newton's London Journal, June, 1860.

native maistries, or foremen of masonry, brickwork, or carpentry, 2*s.* 6*d.*; masons, 1*s.* 9*d.*; bricklayers, 1*s.* 3*d.*; carpenters, 1*s.* 6*d.*; smiths, 2*s.*; miners (a very large class), 9*d.*; excavators, 7½*d.*; and laborers, 6*d.*

The whole of the Great Indian Peninsula Railway had been executed by contract, and this, it was believed, had led to remarkable economy in the construction of the various lines. The average cost of the opened portions had been about £8000 per mile. The introduction of the contract system into India, on a large scale, was an important effect of railway enterprise, and it was thought that its advantage could not be long confined to railway construction.

Railway enterprise had already produced important effects in Western India. It had earned, at a remarkably low tariff, more than the guaranteed dividend. The working expenses had been low, notwithstanding the dearness of imported fuel and European superintendence. It had afforded the advantages of the best mode of conveyance to immense numbers of the poorest and lowest orders of the people. It had generated for itself new sources of traffic. It had achieved its success in competition with water carriage, and when it was only in a fragmental state. Although constructed in what was erroneously called an expensive style, the traffic had already demanded the partial laying of a second line of rails. It had raised the wages and increased the effectiveness of native labor, and profitably employed thousands of the carriers of the country. It had opened quarries and brickfields, had impelled trade into unwonted activity, and drawn largely upon the resources of the country. It had lessened the expenditure of the state, by its cheap conveyance of mails and troops, and had augmented its income, by large payments of tolls and duties. *Proc. Inst. Civ. Eng., May* 8, 1860.

*The North Atlantic Telegraph.**

Long before the Atlantic Telegraph, which has repeatedly failed, was commenced, Col. T. P. Shäffner, an American gentleman of some repute as an electrician, called upon us, we recollect, for the purpose of pursuing certain interesting inquiries into the progress of the electric telegraph in this and other countries. From time to time we have been advised of the efforts subsequently made by this gentleman in the interests of an Anglo-American line of telegraphs, and now we have before us a full statement of the plans to which his prolonged inquiries and investigations have conducted him.

Col. Shäffner proposes to establish a North Atlantic telegraph on the following route, viz: From the North of Scotland to the Bay of Thorshaven, Stromöe Isle, of the Faröe Isles. The length of the cable for this section will be about 250 miles. The next section will run from Westermanshaven, of the same isle, to about Portland, South Iceland, a distance of about 350 miles. From this landing the line

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* From the Mechanics' Magazine, May, 1860.

ill be constructed across Iceland to Reijkiavik. From the Bay of
eijkiavik the next section of cable will be run to some bay on the
ıst coast of Greenland, south of latitude 61 deg. north. This dis-
nce will be about 550 or 600 miles. It is proposed to run the line
ross the southern end of Greenland. The fourth section of cable
ill be run from one of the bays of the west coast, south of the lati-
de 61 deg. north, to Hamilton's Inlet, on the Labrador coast, a dis-
nce of about 600 miles. The aggregate submarine telegraph will
about 1750 miles; land lines about 300 miles, total, some 2050—
out the same length as the Atlantic cable from Ireland to Newfound-
nd. In a paper read a few days since before the Royal Geographi-
l Society, Col. Shäffner quoted the above figures as correct estimates,
d stated that the concession for this telegraph has been granted by
s Majesty the King of Denmark, so far as it may occupy Danish
rritory. There is no monopoly of the line reserved to the Danish
vernment, but its impartial use is guaranteed to the whole world.
he government has pledged itself to "bestow all necessary care,
gilance, and means which may be within its command, to insure the
ee, impartial, and unhindered use of the said telegraph line." If,
wever, the British government should desire a wire for the trans-
ission of its own despatches, a franchise can be given to it, and the
e of that franchise will be defended by the Danish government
with all the means within its command."

The distinguishing feature of this plan is, of course, the shortness
submarine circuits which it secures, and the consequent avoidance
those electrical difficulties which attend the use of very long cir-
its. The longest circuit required will be but 600 miles—which is
0 miles less than one already in successful operation. Through
ch a circuit the promoters say they can transmit at least twenty
rds per minute. "It will be a financial question that will determine
e capacity of the cables for the commercial telegraphy," says Col.
äffner. "Between Scotland and the Faröes, and between the Fa-
es and Iceland, cables can be laid that can equal the working of a
uble line of cables across the other sections of the route, or perhaps
may be found best to construct them for the short sections with two
res for telegraphing, and on the other sections with three or more
nducting wires. If either one of the sections fail, the whole are
t lost, and another cable can be promptly submerged."

The depths of the seas which would be traversed by the proposed
ble are but little known. A few soundings were taken on the route
st autumn, when Col. Shäffner made the voyage from Labrador to
reenland in a 200-ton barque, and effected a reconnaissance of that
rt of the route. His examinations were general, and not in suffi-
nt detail to justify him, in his opinion, in specifying the proper lo-
lities for the landings of the cables; and it is for this purpose, and
r making the most complete survey of the seas and lands, and for
king scientific observations generally, that a government expedition
s been requested, as stated in our last number. Besides the aid to
given by the government in the survey, we understand that a pri-

vate expedition will be sent to fix the route on the respective territories to be traversed by the telegraph. The water between Scotland and the Faröe Islands, and thence to Iceland, is not very deep—not exceeding, perhaps, 1000 fathoms, and there can be no doubt but that the bottom is very deep mud. The soundings taken last fall between Iceland and Greenland, proved the greatest depth of water was 1540 fathoms. The mud brought from the bottom has been examined by Professor Ehrenberg, of Berlin, and he says that he found it "to contain numerous shells with life-being forms therein, which (in his opinion) exist alive at the bottom of the sea." With regard to the sand contained in the specimens, he says, that "it is no rolling sand, but fragmentary, broken, and dissolved stones of mountains. The granules are not round, but with acute sides. The granite sand consists of much glimmer and quartz, with green crystal fragments, whic might be hornblende were there particles of pumice-stone, but whic are not at all therein to be found." It would seem that the bottom o the sea gradually descends to 1540 fathoms from Iceland, and then i the same manner ascends to the Greenland coast. To determine th correctness of this opinion further soundings are required. The Arctic current, perhaps some thirty feet deep, and by some supposed t be fifty miles wide, carries with it large quantities of ice, from whic earth drops to the bottom of the sea. The sea between Greenlan and Labrador was found by Col. Shäffner to be 2090 fathoms, whic was about under the Arctic current, west of Greenland, latitude 6 deg. ·05 min. North-west of this sounding the deepest water foun was 1840 fathoms. The bottom in Davis's Strait was soft mud, excep under the Arctic current, where it was coarse sand, which had bee evidently dropped from the ice. On many icebergs may be seen larg quantities of sand and boulders of several inches in diameter.

The precise places for the landings of the cables have not yet bee determined upon, but Col. Shäffner has brought together many usefu facts for the guidance of the projectors. There are good bays o North Scotland, and there need not be any fears as to that part o the route. The bay of Thorshaven, island of Stromöe, of the Farö group, is approached from the deep sea without obstruction, and it bottom is sand. The average depth of water in the bay is about 2 fathoms. Thorshaven is the capital of the Faröe islands, and ha about 900 inhabitants. The cable to Iceland will leave Westermanshaven on the west coast of the Stromöe Isle. The bay is deep, h says, bottom sand, and free from the ocean waves. On the sout coast of Iceland, about long. 19 deg. W., or at Portland, it is proposed to land the cable. The bottom of the sea approaching nearl the whole south coast of Iceland is sand. The coast is free from ic winter and summer. The cable to Greenland will run, Col. Shäffne continues, from Reijkiavik bay. The depth of water in this bay i favorable, the bottom is mud and sand. It is free from ice, winte and summer, excepting a little crust near the shore. Arctic ice i never seen in that bay, except, perhaps, once in a century. Reijkiavik is the capital of Iceland, and its inhabitants have the highes degree of education. The landing-places on Greenland require to be selected with great care, and after much investigation. It is proposed o land on the east coast, in one of the many bays south of latitude 1 deg. north, and on the west coast near the town of Julianshaab, r south of that place, connecting the two with a line across Greenland. The bays penetrate to the interior ten, twenty, or thirty miles, nd some of them never freeze, nor does the ice from the sea go up hem more than a few miles. They are very deep, and bergs never ground in them ; the bottoms are of mud and sand. The characters f the bays on the two coasts are much the same, and the Arctic current does not approach the coast on either side. From the sea into hese bays the water is deep, far below the reach of the greatest icebergs. To make the selection of the proper bays for the landings of he cables, the fullest information as to the depth of water from the ea will be required. Some of the inlets bring out ice, but most of hem do not; many of them are ten miles wide. As to Labrador, Hamilton's Inlet affords all the desired advantages. This inlet runs nterior about 140 miles, and at its mouth it is thirty miles wide. The water is deep and the bottom is sand. At its mouth there is a deep rench to the sea, and a cable laid in that trench would never be disurbed by the sea. Above and below the mouth of Hamilton's Inlet here are shoals or reefs, some thirty miles from the coast, and many cebergs ground on them. After they melt or break to pieces they ass over and beyond the mouth of the inlet. They never ground at he mouth, nor do they enter into the inlet.

The above statements are made, let it be understood, on Col. Shäffner's authority. We take the following extract also from his Paper:—

> The landings on the Faröe Islands and Iceland will never be disturbed by ice. They re open ports, and vessels can go and come from them at all seasons of the year. The oasts of Greenland and Labrador are beset with much ice. The east coast of Greenland is but little settled. The inhabitants trade with the colony near Cape Farewell, ut they go and return from time to time in their skin-boats. The Arctic or Spitzbergen urrent, with the floe ice, does not approach the coast, and much of the time that the oe ice runs between Greenland and Iceland the water near the coast is free from ice. The floe ice on the east coast may be seen in more or less quantities in the months of February, March, April, May, and a part of June. Sometimes it appears in the last ays of January, and occasionally disappears in May. The coast or berg ice may be een occasionally throughout the year. On the east coast neither the berg nor the floe ce penetrates the bays, and a cable laid therein would never be disturbed by them even were the waters shallow. The hills on the coast are covered with grass and berry bushes. The climate is not severe. The native ice is not very thick, and if it was the cable ould not be injured by it. The west coast in Julianshaab district is settled by some 000 Esquimaux and Danes. Their houses are to be found on many of the hills, and he skin-boats are to be seen at nearly all times in some of the bays. The floe ice runs orthward a few miles from the coast during the months that it is seen on the east oast. Between the green hills and the floe the sea is open and free from ice—except, erhaps, here and there a berg may be seen. Icebergs from Baffin's Bay, or the various "blinks" more northward, will be found scattered along the coast. Some ground on he reefs or shoals, some are blown into the bays, and others pass off to the south. Those blown into many of the bays seldom, if ever, get out. If the bays have currents rom the interior they are taken out to sea, but if their waters be quiet, as many of them re, the bergs are blown to the land and ground. There they remain until the winds, he sun, and the tidal waves crumble them to pieces. Between the Arctic current and he coast many of the icebergs remain for weeks, and, in fact, until broken to pieces and

melted. The largest iceberg may be some eighty feet above water, but as to their dept in the water, no one knows, nor is it possible to ascertain. The theory as to the specific gravity of ice cannot be applied to determine the depth of any given berg. Th ice above water may be the cone ascending from a very broad base. In most case very high bergs are very wide below water, and when the base becomes reduced, th berg falls, and a new projection is seen from the water. The crumbling of bergs, an the changing of their positions, are to be seen going on at nearly all times. A roug sea soon exposes the form and size of the berg, and a careful judgment can determin the probable bulk. The bergs on the Labrador coast are of the same kind as those o the Greenland coast. They go south in great quantities until checked by the eddy currents on the east coast of Newfoundland. Many of them enter the bays of Newfoundland, and a cable laid therein will be more liable to be injured by the ice than those lai on the Greenland or Labrador coasts.

We think Col. Shäffner is likely to meet with all needful encouragement in this attempt of his. The commercial world wants a telegrap to America, and, notwithstanding former failures, are prepared to fin funds for a new attempt, if it has any real promise in it. Regions o thick-ribbed ice do not seem very promising places for telegraphs an telegraphic operations; but late events have familiarized us with thos regions, and there is good reason for believing that the mechanica difficulties which will interfere with the new Atlantic Telegraph wil be more easily surmountable than the electrical difficulties of the mor southern route. In the absence of a mid-Atlantic island or two, i may be wise to run away northward for a bit of land to plant a station upon.

Meantime we must not forget that the old Atlantic Telegraph Company have sent out an expedition for the purpose of restoring thei cable, which has only failed, they say, because a fault in the insulation, which existed before its immersion, was allowed to escape notice They contend that there is reason to believe the insulation remain perfect in the deep-water portion, and that experience affords ground for anticipating the recovery of the injured portions. Mr. Sawar the Secretary to the Atlantic Company, in a letter just received, compares the two rival routes, showing that the extreme length of th existing Atlantic line of Telegraph (from London) is but 2650 mile whilst that of the Danish route will, he says, be 3773 miles. To wor this line of nearly 4000 miles at a remunerative speed would, he adds require relays at each broken point—in all not less than 14 sets relays to be worked in synchronous connexion, each with each. Thes continuous sections, owing in a great degree to their circuitous cours and their constant change of position in reference to the magnetis of the earth—the first links being south to north, then east to wes and lastly, north to south—would, he argues, more than in any othe quarter of the earth, and in a greater ratio than any direct line, b subject to the adverse influences of earth currents, magnetic storm aurora borealis, the chance of accidents, and other disturbing cause always more incident to long and frequently-broken circuits, and an one of which would destroy for days the synchronous working of th relay system, and reduce the operation at best to one of slow an tedious repetition from station to station. "I would further remark, he says—and he is quite right in saying so—"that any survey the Greenland coast, with the view to ascertain its capabilities as a cable station, would not be at all conclusive or satisfactory if it does not embrace, at the very least, eight or nine months' resident examination of the coast, both on its eastern and western sides; as the practicability of that route for telegraphic purposes must depend, not merely upon the bare possibility of laying a cable there during one particular month in a Greenland summer, but upon the probability of its remaining intact during the stormy seasons, and the facilities for rapidly repairing it when broken."

On the Wave-line Theory.[*] By JOHN SCOTT RUSSELL, Esq., F.R.S. Being an abstract from his Paper read before the Institution of Naval Architects, March 3, 1860.

After briefly recapitulating the chief portions of the Paper which he read at the Inaugural Meeting, two days before, the Author said his object in his present Paper was to consider the nature of the motion imparted to water when disturbed by a vessel pushed through it by motive power of any kind. It was in the investigation of this subject that he had seen some of the most important principles that guide us as to the general proportions of ships, as well as their shape, with reference especially to velocity.

The first inquiries to be made were,—what became of all the water which a ship removed out of her way? and how did it get out of the way? In prosecuting these inquiries the Author had first employed a small trough or canal, a foot wide, a foot deep, and of considerable length, and began with a very simple experiment. He supported a small heap of water above the level of that in the trough by means of a partition at one end, and then withdrew the partition to see what the water would do, and found that it assumed a beautiful wave-form of its own, ran along the whole length of the channel to the end, and left the surface of the water over which it passed as still as it was before. Had the end of the trough been just level with the surface of the still water, the wave would have jumped over and left the whole of the water in the canal perfectly undisturbed. This phenomenon is now known as the "solitary wave of translation." This wave would travel to an almost incredible distance. The Author had followed such a wave on horseback, and by other means, for miles. It leaves a little of itself, however, along the whole surface over which it passes.

The next fact ascertained was that, whenever the bow of a ship is moved through the water a wave of this kind is produced, and this is the "traveling" or "carrier wave," which gets rid of all the water out of the canal which the vessel has to excavate. The ship feels no more of it, for it spreads itself in a thin film all along the surface of the water ahead of the vessel—not behind the vessel, nor on each side of it—with a far greater velocity than that of the vessel itself. After having made experiments on a small scale, the Author took vessels on a large scale, had them dragged by horses, and in other ways, through the water, and by positive observations and measurement found that this was really what became of the water displaced by the bow of a boat. On one occasion he drew so large a number of boats along a canal in one direction, on a certain day, that the waves carried a great part of the water from one end of the canal to the other, and in the evening the water in the canal was found raised 18 inches at one end, and depressed to the same extent at the other. The velocity with which the traveling wave moved was found to depend entirely on the depth of the water.

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[*] From the Lond. Mechanics' Mag., April, 1860.

At	3	feet deep	the wave travels	6	miles an hour.
"	5	"	"	8	"
"	7	"	"	10	"
"	10	"	"	12	"
"	15	"	"	15	"
"	20	"	"	18	"
"	30	"	"	20	"
"	40	"	"	25	"
"	50	"	"	30	"

In addition to a constant velocity this wave has a constant shape, a drawing of which was exhibited by the Author. And a most extraordinary circumstance was that its form corresponded exactly with the form of bow which he had previously, and from altogether different considerations, constructed as the form of least resistance. Moreover, he found that what he had endeavored to do in constructing that form, viz : move the particles of water gradually out of the way from one position of rest to another, the traveling wave also did ; for on closely observing the water in the experimental trough under the action of such a wave, he observed that it lifted every particle of water over which it passed out of one place forward into another place, and there left it perfectly at rest. In the traveling wave, therefore, as in ordinary waves, the particles of water composing it were continually being replaced by others, while the wave itself advanced without apparent change. The foregoing facts convinced the Author that the form of bow which he had adopted, and which has since been called the "wave form," was analogous and conformable to the nature of water and of wave motion.

Like many others, the Author at first thought that the stern of a vessel ought to be of the same form as the bow ; but thought it proper to undertake a series of experiments with the view of ascertaining what happened when a hole in the water had to be filled up. Where did the water that filled it come from ? And how did it come ? He first found that the hollow made in the water had no tendency to travel with an independent velocity of its own, but moved just as fast, and only as fast, as the body which produced it. He then discovered that the currents of water rushing into such a hollow, from different directions, met and produced a wave, which he called the "following wave," or the "refilling" or "replacing wave," and which always moved with the velocity of the ship, and had nothing to do with the depth of the water. The "following wave" also repeated itself in an endless series astern of the vessel. The Author explained that the nature of this wave required that the stern of the ship should be formed of cycloidal curves, and showed how this fact was applied in actual construction.

The Author might be asked (reverting to the wave at the bow)—what became of the water at the bow supposing he dragged the boat faster than the water could spread itself? The answer was—With only a moderate force at his disposal the boat could not be made to travel faster; but if he had force enough to compel it to go in spite of the water, the water would rise up and stand on both sides of the boat until the load had passed, and then fall down into the hole left behind it. In a shallow canal in Scotland, where the carrier wave traveled only seven miles an hour, he had compelled a boat to go ten miles, and he found that the water not only rose up, but lifted the boat with it, so that she drew less water than before, and actually went easier at ten miles an hour than at five. Had not railways come into fashion just at the time, the country would have been covered with little troughs, and people would have been riding on the tops of these waves in an easier and cheaper mode than by any other means then known.

After explaining the different results which are sometimes obtained at trials in the Thames, owing to the velocities of the traveling wave varying with the depths of the water, the Author described the best means of observing the wave on rivers and other like places, and then proceeded to the application of some of the principles before laid down to practice. First, he said it was a delightful circumstance that the wave principle did not meddle at all with the form of a ship's midship section, but left the conductor entirely free to adopt any form of section he pleased. Next, it did not tie him down to any proportion of depth to breadth. It was, therefore, a plastic thing, and could be applied to any general form of ship whatever. The third and most important proposition was, that the wave-line prescribed the exact length of ship for every speed at which you wished a ship to go, and explains why a long ship is indispensable to speed. To go six miles an hour, your vessel must be at least 30 feet long; for eight miles an hour, 50 feet long; for 10 miles, 70 feet; for 12 miles, 100 feet; for 15, 150; for 18, 200; for 20, 300; for 25, 400; and for 30, 500. The Author had himself tried to obtain higher velocities than these with shorter vessels; and he had got them, but at such a fearful waste of power that it was insanity and folly not to lengthen the vessels for the purpose. The wave-line theory also told you that the length of the bow should be to that of the run as 3 to 2. The cause of this was explained.

The lines of the Great Eastern, the Author said, were neither more nor less than an exact copy of the wave-lines. The length of the bow was 330 feet; the length of the run 226 feet; and having got this length of entrance and run, and feeling that more capacity was wanted, it was of no use lengthening the bow or the run, because there was already provision for greater speed than the 15 miles an hour which the power to be put into her could be expected to give; 120 feet o parallel body were therefore put into her amidships. The great shi might be of less fine-lines and still go with the same velocity.

There was a very valuable conclusion for practical ship-builders t be drawn, independently of what had been stated about the lines. I was this: that proportionate length and breadth were not necessar at all for a fast vessel. It was not necessary for a fast vessel tha she should be a narrow, thin, long vessel in proportion to her size The Author had taken vessels on the wave-line principle 200 feet long and had made them of every variety of breadth, and as long as the were 200 feet long and had the lines belonging to 15 or 16 miles a hour, so long they had gone at that velocity with a given power. Further, the resistance which a vessel experiences from the sticking o water to the skin was a most formidable element of her whole resistance; and greater velocity in proportion to power would be got ou of a vessel which was shorter than another, and also broader an deeper than another, providing length enough for the velocity aime at were got at starting.

The Author's paper next contained remarks upon the effects of th wave-line upon the stability of ships—its bearing upon the load-wate line—how it affected the form of the deck—how it should affect th structure of the vessel—how vessels should be built upon it so as t have a maximum of capacity—how the various proportions of length breadth, and depth affected resistance—how the whole form could b so managed as to properly arrange the balance of the ship—how the wave-line affected the navigable qualities of a ship—how it affecte the materials of which the ship should be built—and how it influence the properties of sailing ships, paddle-steamers, and screw-steamers respectively. But these considerations could not then be gone into They would, however, appear in the Institution's forthcoming *Transactions.*

It was the duty of the Author, however, to say a word or two on the history of the subject, and the degree of novelty or non-novelty to which it pretended. And he begun with saying that he did not claim to be the inventor of hollow bows. They had existed as far back as he could trace steam navigation. When he had first discovered what he believed to be the principles of nature which bore on this subject, he felt that the form of vessel which accorded with them could not be new, and he set about examining all classes of vessels. He found proofs immediately; so many that he felt astonished that the books and treatises on naval architecture had not all told them to do nothing but make hollow bows from the beginning. He showed that it must have been impossible for barbarous men to have made a rough boat from two flat planks without forming such a bow. But the old tonnage laws had compelled builders to make ships of the greatest possible capacity compatible with certain measurements. Hence the bluff bow was made a matter of necessity. When, during the wars, we captured Spanish ships or privateers with fine and often hollow lines below—vessels which sailed admirably under their original trim, in which they were down by the stern, we invariably found that they proved but dull sailers in our hands, owing undoubtedly to the fact that we not only overloaded them with weights, but trimmed them nearer to an even keel, and so brought the bluff upper part of their bows down into the water. The boats of the London watermen illustrated the same principle. The Author next alluded to the *Vesper*, built from Mr. Ditchburn's design by Fletcher and Fearnall, in which, on coming to London in 1836 or 7, he found a confirmation of the views which he had embodied in the *Wave* in 1835. He also referred to a boat built by the late Mr. Assheton Smith, and to several other vessels built successively by himself and others.

The Author concluded by stating that the rapid advancement of confidence in the wave principle was owing very much to the British Association for the Advancement of Science, which had placed at his disposal large means for the prosecution of scientific researches into this subject, and had every year enabled him to publish to the world the progress which he was making in the investigation.

*State of Railways in Spain.**

At the close of the year 1859, the following was the state of railways in Spain, with their annual receipts:—

	Kilometres in length.	Receipts 1859. Reals vellon.
Madrid to Alicante, . . .	482	44,228,893
Madrid to Saragossa, . .	57	2,126,720
Cordova and Seville, . . .	131	4,259,146
Valencia and Almansa, . .	138	6,430,425
Alar and Santander, . . .	91	8,540,372
Barcelona to Saragossa, . .	37	2,905,680
Barcelona to Martorell, . .	27	2,083,765
Barcelona to Arenys, . .	36	4,185,787
Barcelona to Granollers, . .	29½	2,742,050
Jerez to Trocaders, . .	27½	3,717,403
Langres and Gijon, . . .	39	
Tarragon, . . .	14	761,198
Totals, . .	1109	81,981,444

The Langres and Gijon line, in 1858, received 1,832,071 reals vellon (1*l.* = 96 reals vellon).

On the Decay and Preservaton of Building Materials.† By Prof. Ansted.

Prof. Ansted commenced by directing attention to the state of the stone in many of the principal buildings in England and on the Continent, illustrating the extreme irregularity with which various materials, and even various samples of the same material, resist the action of the weather and fall into decay. He then described the chief building materials, explaining in each case the cause of decay. Commencing with a general remark, that all stones are rotten and weathered at the top of a quarry or near an earthy surface, and that the action of the weather on them is in some measure thus indicated, he first alluded to granite. He stated its properties of hardness and great durability in ordinary cases; but remarked that when soda replaced potash in the felspar, the crystals of felspar were subject to the action of the weather, and that, from some cause little known, the silica base also occasionally failed. Still, the great practical objection to the use of granite is its cost. Passing next to the sandstones, he defined them, mentioning the chief varieties. He stated that the nature of decay in sandstones was generally the failure of the cementing medium, which is sometimes silicious, but more frequently calcareous, or clayey, or even oxide of iron. He pointed out as the causes of decay, the want of sufficient cohesion in the cementing medium—the nature of the cementing medium itself, and the effect of expansion and contraction of water absorbed by the stone. The limestones were next considered, and the principal varieties passed briefly under review. They are all freestones—some are crystalline, others semi-crystalline, but most of them are earthy, or oolited and absorbent. They consist of particles of carbonate of lime, whether grains, as in the case of chalk, or accumulated lumps like oolite or roe-stone, or fragments of shell; and these particles are cemented together by carbonate of lime. The stones are generally laminated, though the bedding is often extremely obscure. When exposed to the action of the air in towns, they absorb moisture and acid gases very readily, and the result is a gradual destruction of the surface, and often a rapid removal of the particles beneath the surface, especially on the planes of bedding. When stones are not placed in a building as they were in the quarry, the surface peels off in natural films, and is more rapidly acted on than it need be; but not unfrequently, even when well placed, the surface gets hardened by exposure more rapidly than the substance of the stone, and a scaling still takes place. The more exposed parts, those subject to drip and constant damp, and the more delicately sculptured portions, are among the first to decay; and, owing probably to differences in the mode or rate of deposit of the mud of which the limestone was formed, or some partial change that has since taken place, there is great irregularity in the rate of decay. Magnesian limestones, or dolomites, when quite crystalline, behave like marble; but when, as is usual, only half crystalline, they are very apt to become reduced to powder in parts, and the decay thence proceeds with extreme rapidity. The Professor next proceeded to consider the remedies for decay. He alluded to paint as at once unsightly and not permanently beneficial, and included the large class of preservatives that have been suggested, in which any animal or vegetable oil or fatty matter was contained, as equally valueless, either peeling off or rotting in the stone, and leaving it soon exposed to ordinary decay. The mineral bitumens, he stated, had not been much tried, owing to their dark, unsightly color. What is required is some mineral preparation. He then alluded to the water-glass, a soluble silicate of potash, originally described by Dr. Fuchs, and applied to indurate stone by M. Kuhlmann. He explained the principle of this process as depending on slow decomposition by exposure to the air, and stated, that, as meanwhile the influences of the weather continued to act, the method could not be adopted with advantage in the open air in a damp climate, where preservation is chiefly required. The only plan that, as far as he was aware, met the requirements of the case, he stated to be that adopted by Mr. Ransome, according to which the absorbent surface, whether of stone or terra-cotta, was saturated with the diluted solution of soluble silicate of soda, and then treated with a solution of chloride of calcium. By the mutual action of these solutions, a double decomposition is induced, the silicic acid parting with its soda to the chlorine, producing chloride of sodium, or common salt, and combining with the lime to form silicate of lime. The salt being washed away, only the silicate of lime remains. The silicate of lime thus thrown down he next explained to be a salt, which was not only itself non-absorbent and singularly powerful in resisting the action of ordinary atmospheric influences, but as having the property of adhering rapidly to the surface of the minute particles of which stone was formed. He illustrated this by the case of mortar and concrete, which owe their adhesive properties to this habit of silicate of lime, which is the mineral formed by the mutual action of the cement on the substances in contact with it. The stone having its particles thus coated with silicate of lime, and all the absorbent surface being thus protected, the result is an immediate and great hardening of the stone, so far within its substance as the solutions have been absorbed, and a complete immunity to that extent from the action of atmospheric influences. The stone does not necessarily become non-absorbent, though it can be made so; but it absorbs much less rapidly than before, and appears to resist decay much in the way that some of the best natural sandstones, such as Craighill, are known to do.

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*From the London Builder, No. 893.

† From the Lond. Athenæum, May, 1860.

*Do Railway Rails ever wear out ?**

At the late meeting of the West Flanders railway, Mr. Herapath having mentioned on the experience of one of our ablest practical railway men, that the rails, unless at the stations and places where there is skidding, do not sensibly wear out, was afterwards spoken to upon the subject by a gentleman, and a railway chairman, who seemed to misunderstand what Mr. Herapath said, and adduced the splitting and exfoliation of some of the rails in disproof of what they called a theory. Lest others should run away with the same mistaken notions and misapprehensions, we think it necessary to say that the non-wearing out applies to rails made with good iron, not inferior iron tinned over, as it were, with good, of which far too many rails are made, and to rails on the middle of a line over which the trains run in the ordinary way. Experiments have been made, by taking up and carefully weighing rails in this position after 12 months wear, or more, which were found not sensibly to have lost any weight during that time, thereby proving that there could have been no sensible wear. Besides, we have been assured that after being down for many years, they showed no signs of material wear, which justified the statement which Mr. Herapath made, on the authority given him. It is true that near stations and places of shunting where there is much sliding and slipping by the application of the brakes, or otherwise, there is very sensible wear. But this is caused by slipping friction, not rolling, which is incomparably less than the former, though it seems we have ex-railway chairmen quite innocent of the knowledge of that simple fact.

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*From Herapath's Railway Journal, No. 1091.

MECHANICS, PHYSICS, AND CHEMISTRY.

*New Secondary Pile of great power.** By M. G. Planté.

Jacobi proposed recently the use of secondary electric currents for telegraphic purposes, and Planté had suggested the substitution of electrodes of lead for those of platinum in these batteries. A more extended study has convinced him of their use. He states that a battery with electrodes of lead has 2½ times the electromotive force of one with electrodes of platinized platinum, and six times as great as that of one with ordinary platinum. This great power arises from the powerful affinity which peroxide of lead has for hydrogen, a fact first noticed by De la Rive. The secondary battery which he recommends has the following construction. It consists of nine elements, presenting a total surface of ten square metres. Each element is formed of two large lead plates, rolled into a spiral and separated by coarse cloth, and immersed in water acidulated with one-tenth sulphuric acid. The kind of current used to excite this battery depends on the manner in which the secondary couples are arranged. If they are arranged so as to give three elements of triple surface, five small Bunsen's cells, the zincs of which are immersed to a depth of seven centimetres, are sufficient to give, after a few minutes action, a spark of extraordinary intensity when the current is closed. The apparatus plays, in fact, just the part of a condenser; for by its means the work performed by the battery, after the lapse of a certain time, may be collected in an instant. An idea of the intensity of the charge will be obtained by remembering that to produce a similar effect it would be necessary to arrange 300 Bunsen's elements of the ordinary size (13 centimetres in height), so as to form four or five elements of 3½ square metres of surface, or three elements of still greater surface. If the secondary battery be arranged for intensity, the principal battery should be formed of a number of elements sufficient to overcome the inverse electro-motive force developed. For nine secondary elements about fifteen Bunsen's cells should be taken, which might, however, be very small.

From the malleability of the metal of which it is formed, this battery is readily constructed; by taking the plates of lead sufficiently thin, a large surface may be placed in a small space. The nine elements used by Planté are placed in a box 36 centimetres square, filled with liquid once for all, and placed in closed jars; they may also be kept charged in a physical cabinet, and ready to be used whenever it is desired to procure, by means of a weak battery, powerful discharges of dynamic electricity.—*Comptes Rendus, March 26th*, 1860.

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* From the Lond. Ed. and Dub. Phil. Mag., June, 1860.

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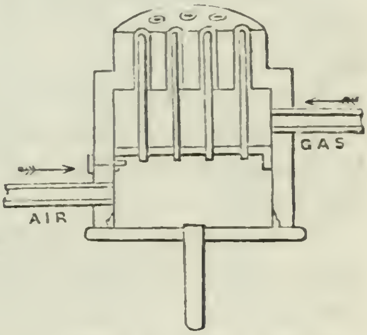
*Description of a Patent Blast Gas Furnace.** By J. J. Griffin, F.C.S.

The patent blast gas furnace consists of two parts, namely, of a particular form of gas burner, which is supplied with gas at the usual pressure, and with a blast of common air, supplied by bellows or a blowing machine, at about ten times the pressure at which the gas is supplied.

Secondly, of a furnace which is built up in a particular manner, round the flame that is produced by the gas-burner, and the crucible that is exposed to ignition. The object of the particular construction of this furnace is to accumulate and concentrate in a focus the heat produced by the gas flame, and to make it expend its entire power upon any object placed in that focus.

This apparatus can be made of various sizes, according to the amount of work which is required from it. We describe below a few varieties of the furnace, and the results of some experiments made with them, which will show the reader what kind of work it is able to execute.

Fig. 1.



The Gas-burner.—The gas-burner is a cylindrical iron reservoir, containing two chambers, which are not in communication with one another. Into the upper chamber, gas is allowed to pass; and into the lower chamber, air is forced by means of tubes. The upper part of the burner is an inch thick in the metal. Through this solid roof, holes are bored for the escape of the gas. The experiments described hereafter were made with a burner that contained sixteen holes; but burners with six holes, and with twenty-six holes, have been made for other purposes. The number of holes depends, of course, upon the heating power required from the burners. The air passes from the lower chamber, through a series of metal tubes, placed in the centre of the gas-holes, and continued to the surface of the burner, so that the gas and air do not mix until both have left the gas-burner, and then a current of air is blown through the middle of each jet of gas. The bottom of the gas-burner is made to unscrew, and the division between the two chambers, which carries the air-tubes, is easily removable, for the purpose of being cleaned. The gas and air pipes are both half an inch in the bore, and are ten inches long the gas has usually had a pressure of half an inch of water, and th blast of air about ten times that pressure. The quantity of gas use in an hour was about 100 cubic feet. The stop-cock which supplie it had a bore of half an inch.

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* From the London Chemical News, No. 3.

When the gas is lighted and the blast of air is put on, the flam produced by the gas-burner is quite blue and free from smoke. It i two inches in diameter, and three inches high, and the point of greates heat is about two inches above the flat face of the gas-burner. Abov this steady blue flame there rises a flickering ragged flame severa inches in height, varying with the pressure of the gas. In the blue flam thin platinum wires fuse readily.

When the gas is burning in this manner, and the apparatus is attached to flexible tubes, the burner may be inverted or held sideways without disturbing the force or regularity of the flame, so that th flame may be directed into a furnace at the bottom, the top, or the side as circumstances may require.

The following articles are used in building up a gas furnace fo different experiments. They vary in size according to the volume o the crucible, or the weight of the metal which is to be heated.

1. A circular plate of fire-clay, two inches thick, with a hole in th centre, which exactly fits the upper part of the gas-burner, which i made to enter into the hole three-quarters of an inch. In externa diameter, this clay plate agrees with each size of furnace.

2. A cylinder of fire-clay, of which two pieces are required to constitute the body of each furnace. In the middle of each cylinder, a trial hole is made, one inch in diameter, to which a fire-clay stopper i adapted.

3. A fire-clay cylinder, closed at one end and pierced near the open end with six holes, of half an inch in diameter. The thickness of the clay is immaterial.

This cylinder is three inches high and three inches in diameter.

4. A circular plate of fire-clay, two and a half inches or three inches in diameter, and one inch thick. Similar pieces half an inch thick are useful.

5. A cylinder of plumbago, to be used as a crucible support. It is three inches inside diameter and one inch in height. It is pierced with twelve holes of three-eighths of an inch bore.

6. A similar cylinder of plumbago, two inches high, pierced with twenty-four holes of three-eighths of an inch bore.

7. A thin plate of plumbago, three inches in diameter, namely, o the same diameter as the above three cylinders. It has a small hole in the middle, and being of soft material, the hole can be easily cut or filed to suit crucibles of any desired size.

To suit the larger kinds of crucibles and furnaces, cylinders are made resembling the above in form, but of greater diameter.

As in all cases the heating power of the gas furnace spreads laterally and does not rise vertically, the most advisable form of the crucibles required for use in it is *short and broad*, not tall and narrow, and the upporting cylinders must be shaped accordingly. No fire-bars or rates can be used to support crucibles in this gas furnace, because no aterial formed into narrow bars can sufficiently withstand its powers f fusion and combustion.

8. A plumbago cylinder, or crucible-jacket, two and a half inches igh, two and a half inches in diameter, and a quarter of an inch thick n the walls. It has six holes of three-eighths of an inch diameter ear one end.

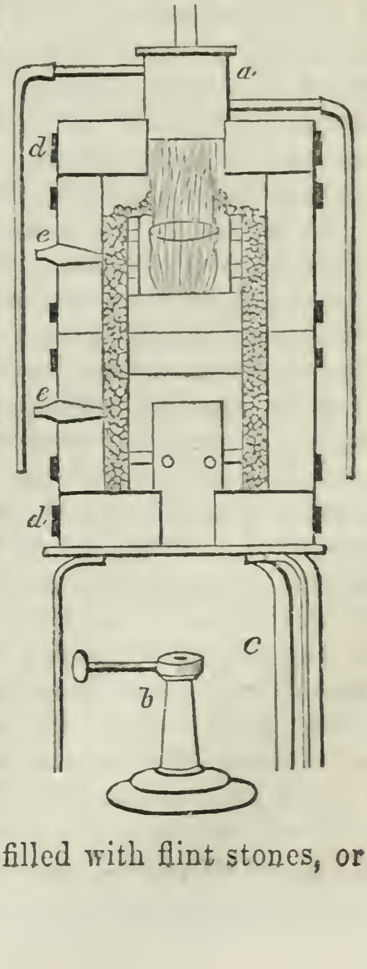
9. A circular cover or dome, flanched at the bottom, and having a nob or handle at the top. It is pierced with twenty-four holes of a uarter of an inch in diameter, arranged in two rows near the bottom. This dome, when of small size, is made of plumbago. When of large ize, of fire-clay.

10. Plumbago crucibles made with a solid overhanging rim, the use f which is to suspend the crucibles over the gas-burner, by means of he cylinders Nos. 5 and 6. When the crucibles are too small to fit he cylinders, the flat plate (No. 7) is filed to fit the crucible, and is hen placed on the cylinder, to whose diameter it is adapted.

Besides these pieces of fire-clay and plumbago, it is necessary to be rovided with a strong iron tripod to sustain the furnace; an iron an in which to place the furnace; and a quantity of gravel, or rounded ints, not less than half an inch, nor more than one inch in diameter. hese pebbles form an essential part of this gas furnace.

Gas Furnace, heated at the top, exhibited n section by Fig. 2.—*a* is the gas-burner Fig. 1); *b* is the support for it when used elow the furnace; *c* is the iron tripod support for the furnace; *d d* are two perforated lay plates (No. 1) adapted to the gas-burner *a*; *e e* are two clay cylinders like No. 2. hese pieces, *a* to *e*, are similar in all the urnaces and will not require description in ach example.

Fig. 2.



The interior of the furnace, as represented y Fig. 2, is built up as follows:—The clay late *d*, is put upon the tripod *c*. Over the entral hole in *d*, the clay cylinder (No. 3) s placed, and upon that cylinder two or hree of the clay plates (No. 4). Upon hese a porcelain or platinum crucible is laced. If it is of platinum, a piece of platinum foil may be put between the crucible nd the uppermost clay plate to protect the rucible from contact with particles of iron, r against fusion with the clay. The crucible is to be covered by the plumbago jacket, o. 8. The space between this pile in the entre of the furnace and the two cylinders *ee*, hich form the walls of the furnace, is to be filled with flint stones, or gravel, washed clean and dried. The stones which answer best are rounded, water-worn pebbles of half an inch to one inch diameter. These may be piled up to the top edge of the jacket (No. 8). The number of clay plates (No. 4) must be such as to bring the top of the crucible to the distance of two inches, or two and a half inches at the utmost, from the flat face of the gas-burner *a*. In some cases, merely one of the furnace cylinders *e* is necessary, in which case the crucible and its jacket is placed directly upon the cylinder (No. 3), and when only a moderate heat is required, even the packing with pebbles may be dispensed with. Another means of diminishing the heat is that of increasing the distance between the gas-burner and the crucible.

The apparatus being thus arranged, the gas is to be turned on, and to be lighted, the blowing machine is to be put into action, and the nozzle of the gas-burner is to be depressed into the central hole of the clay plate *d*. The whole force of the blue flame then strikes the crucible; part of it forces its way through the holes in the jacket (No. 8), and part of it rises and passes over the upper edge of the jacket; after which it forces its way downwards between the pebbles. The carbonic acid gas and the vapor of water which result from the combustion of the gas, together with the nitrogen of the air, and any uncombined oxygen, accompany it. No space being left open for the escape of these gases at the upper end of the furnace, they go downwards through the interstices among the pebbles, and passing through the holes in the cylinder (No. 3), and through the central hole in the lower plate *d*, they escape finally into the air. In this progress the hot gases give up nearly all their heat to the flint stones. Water and gases escape below at a very moderate temperature, water even runs down in the liquid state, while the stones rapidly acquire a white heat, and if the blast and the supply of gas is continued, they retain that white heat for any desired length of time—for hours.

At the end of ten minutes after lighting the gas, the crucible, placed in the desired circumstances, and exposed to the full action of the heat of the gas, and surrounded by substances which are bad conductors of heat, is raised, with the jacket and pebbles around it, to a white heat. The consequence is, that the full power of the gas-jet is then exerted upon the crucible and its contents, and those effects are produced which will be described presently.

If it is desired to inspect the substances subjected to the action of heat in this furnace, the gas-burner is lifted out, and the crucible is examined through the hole in the clay plate. To make it possible to inspect substances at a white heat, the view is taken through a piece of dark cobalt blue glass. If the substances submitted to heat suffer no harm from the action of oxygen, it is better to dispense with a crucible cover, and to direct the jet of flame directly down upon the substance to be heated. The action is then more rapid. When the burner is taken out, the substance in the crucible can be stirred, if it is considered necessary.

The following experiment will give an idea of the power of a furnace of this description. A common clay crucible, three inches high and hree inches diameter at the mouth, was filled with about 24 ounces of ast iron. It was mounted as in Fig. 2, in a furnace of four inches nternal diameter, and eight inches deep. The pebbles were filled in o the edge of the crucible. No crucible cover and no jacket were sed. The flame was thrown directly upon the iron. In a short time he iron melted, the oxygen then converted some of the cast iron into agnetic oxide of iron, which formed a thin, infusible mass on the urface of the cast iron. At twenty minutes from the lighting of the as, the furnace was dismounted. The crucible was taken out. A ole was broken by an iron rod in the infusible surface of oxidized ron, and the fused cast iron below it was decanted into a mould, and ade a clear casting weighing twenty ounces.

In the same small furnace 32 ounces of copper can be fused in 15 minutes. When the furnace is hot, that quantity of copper or cast ron can be fused in 10 minutes.

In a furnace of the same dimensions, but with a gas-burner having nly six, instead of sixteen jets, 16 ounces of copper or of cast iron an be completely fused in ten minutes if the furnace is cold, and in even minutes if the furnace is hot.

These experiments show that within twenty minutes a heat is producible in this little furnace which is more than sufficient for the decomposition of silicates by fusion with the carbonates of potash, soda, r barytes.

(To be Continued.)

Serrin's Automatic Regulator for Electric Lamps.

The two tubes which carry the carbons are placed vertically, the one ver the other; and communicate, the upper with the positive pole of he battery, the lower, by means of a train of wheels and the oscillating apparatus, with the negative pole. When the positive carbon descends by its own weight, it lifts the negative carbon through one-half f the distance, so that, as the negative carbon wastes only one-half s fast as the positive, the light is kept in the same place. The oscillating apparatus is a jointed rectangle, two of whose sides are vertical, he others horizontal; one of the vertical sides is fixed, and the other s movable and very delicately suspended so that it may either descend y its own weight or rise by the power of a spring which presses it pward. The apparatus carries at its lower part a soft iron armature orresponding with an electro-magnet operated on by the current of the battery.

When the current is not passing, the carbons are in contact; but as soon as the current is closed, the magnet becomes active, the armature is drawn down, the oscillator sinks carrying with it the negative carbon, which thus separates from the positive carbon which remains in its place, then the light appears between the points. As the carbons are consumed, their distance apart increases, the current is enfeebled, the magnet is weaker, the armature less attracted, and the oscillator rises; in rising, it disengages the train and the carbons approach each other. As the apparatus is very sensitive, these are rather tendencies to movement or change, than actual changes. If an accident should happen, if one or both of the carbons should break, the current is suddenly interrupted, the magnet ceases to act, the oscillator rises, and allows the train to start and replace the carbons in their proper positions. The play of this apparatus is so steady and easy that it will work with the alternating currents from the electro-magnetic machine. The lamp is lighted or extinguished the moment the current is established or interrupted. The lamp, therefore, becomes very suitable for telegraphic signals or for light-houses, in which, by these means, the flashes may be obtained without any mechanism for rotation.—*Academy of Sciences of Paris.*—*Cosmos.*

Mode of Etching on Glass.

A painter at *Bourg-en-Bresse* in France, reports to the *Cosmos* the following singular and valuable experiment: He traced upon a piece of glass a design in white-lead mixed with linseed-oil, and when it had dried, he laid it for a few minutes over a vessel in which hydro-fluoric was generating. When the glass was removed, it was found that the parts of the glass covered by the white paint were etched, while those uncovered had not been attacked. Should this observation be confirmed, it would seem to open a new field to glass-etchers.

*Loss of Light by Glass Shades.** By William King.

Sir:—Having recently tried some experiments, for the purpose of ascertaining the amount of light lost by the use of various descriptions of glass shades, I thought that the results obtained might not prove uninteresting to some of your readers, more especially as it is a subject of practical importance, and does not seem to have attracted the notice which it deserves.

The following table exhibits the amount of light lost by the use of the various shades therein enumerated:—

Description of shade.	Loss of light.
Clear glass, ...	10·57 per cent.
Ground glass (entire surface ground), . .	29·48 “
Smooth opal, ...	52·83 “
Ground opal, ...	55 85 “
Ground opal, ornamented with painted figures, the figures intervening between the burner and the photometer screen, .	73·98 “

As the large amount of light lost by the use of a clear glass shade excited some surprise, a sheet of common window glass was placed between the burner and the photometer screen, when it was found that 9·34 per cent. of the light was intercepted, thus confirming the result obtained by the employment of a shade of clear glass.

I may state that the shades were selected from a large number, and great pains were taken to obtain an average specimen of each kind.

Liverpool, Feb. 24, 1860.

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*From the Lond. Jour. of Gas Lighting, &c., No. 192.

A Course of Lectures, consisting of Illustrations of the Various Forces of Matter, i.e. *of such as are called the Physical or Inorganic Forces.**

By M. Faraday, D. C. L., F. R. S.,

Lecture II. (Jan. 3, 1860.)—*Gravitation.—Cohesion.*

Do me the favor to pay me as much attention as you did at our last meeting, and I shall not repent of that which I have proposed to undertake. It will be impossible for us to consider the Laws of Nature, and what they effect, unless we now and then give our sole attention, so as to obtain a clear idea upon the subject. Give me now that attention, and then I trust we shall not part without your knowing something about those Laws, and the manner in which they act. You recollect, upon the last occasion, I explained that all bodies attracted each other, and that this power we called *gravitation*. I told you that when we brought these two bodies [two equal sized ivory balls suspended by threads] near together they attracted each other, and that we might suppose that the whole power of this attraction was exerted between their respective centres of gravity; and, furthermore, you learned from me that if, instead of a small ball, I took a larger one, like *that* [changing one of the balls for a much larger one], there was much more of this attraction exerted; or, if I made this ball larger and larger, until, if it were possible, it became as large as the Earth itself—or I might take the Earth itself as the large ball—that *then* the attraction would become so powerful as to cause them to rush together in this manner [dropping the ivory ball]. You sit *there* upright, and I stand upright *here*, because we keep our centres of gravity properly balanced with respect to the earth; and I need not tell you that on the other side of this world the people are standing and moving about with their feet towards our feet, in a reversed position as compared with us, and all by means of this power of gravitation to the centre of the earth.

I must not, however, leave the subject of gravitation without telling you something about its laws and regularity; and first, as regards its power with respect to the distance the bodies are apart. If I take one of these balls and place it within an inch of the other, they attract each other with a certain power. If I hold it at a greater distance off, they attract with less power, and if I hold it at a greater distance still, their attraction is still less. Now this fact is of the greatest consequence; for, knowing this law, philosophers have discovered most wonderful things. You know that there is a planet, Uranus, revolving round the sun with us, but eighteen hundred millions of miles off; and because there is another planet as far off as three thousand millions of miles, this law of attraction, or gravitation, still holds good, and philosophers actually discovered this latter planet, Neptune, by reason of the effects of its attraction at this overwhelming distance. Now I want you clearly to understand what this law is. They say (and they are right) that two bodies attract each other *inversely as the square of the distance*,—a sad jumble of words until you understand them; but I think we shall soon comprehend what this law is, and what is the meaning of the "inverse square of the distance."

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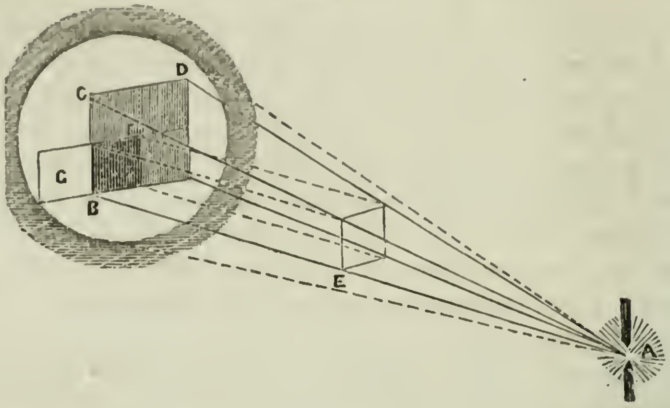
* From the Lond. Chemical News, No. 6.

I have here (Fig. 1) a lamp A, shining most intensely upon this disc BCD, and this light acts as a sun by which I can get a shadow from

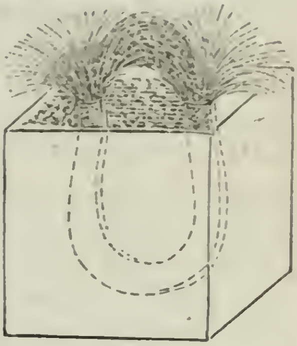
Fig. 1.



this little screen BF (merely a square piece of card), which, as you know, when I place it close to the large screen, just shadows as much of it as is exactly equal to its own size; but now let me take this card E, which is equal to the other one in size, and place it midway between the lamp and the screen; now look at the size of the shadow BD, it is four times the original size. Here, then, comes the "inverse square of the distance." This distance AE, is *one*, and that distance AB, is *two*, but that size E, being *one*, this size BD of shadow is *four* instead of *two*, which is the *square* of the distance; and if I put the screen at one-third of the distance from the lamp, the shadow on the large screen would be *nine* times the size. Again, if I hold this screen *here* at BF, a certain amount of light falls on it; and if I hold it nearer the lamp at E, *more* light shines upon it. And you see at once how much—exactly the quantity which I have shut off from the part of this screen BD, now in shadow; moreover, you see that if I put a single screen here at G, by the side of the shadow, it can only receive *one-fourth* of the proportion of light which is obstructed. That, then, is what is meant by the *inverse* of the square of the distance. This screen E, is the brightest because it is the nearest, and there is the whole secret of this curious expression *inversely as the square of the distance.* Now, if you cannot perfectly recollect that when you go home, get a candle and throw a shadow of something—your profile, if you like—on the wall, and then recede or advance, and you will find that your shadow is exactly in proportion to the *square* of the distance you are off the wall; and then if you consider how much light shines on you at one distance, and how much at another, you get the inverse accordingly. So it is as regards the attraction of these two balls, they attract according to the square of the the distance, inversely. I want you to try and remember these words, and then you will be able to go into all the calculations of astronomers, as to the planets and other bodies, and tell why they move so fast, and why they go *round* the sun without falling into it, with many other curious things.

Let us now leave this subject which I have written upon the board under the word FORCE—GRAVITATION—and go a step further. All bodies attract each other at sensible distances. I showed you the electric attraction on the last occasion (though I did not call it so); that attracts at a distance; and in order to make our progress a little more simple, suppose I take a few iron particles [dropping some small fragments of iron on the table]. There, I have already told you that in all cases where bodies fall, it is the *particles* that are attracted. You may consider these, then, as separate particles magnified, so as to be evident to your sight; they are loose from each other—they all gravitate—they all fall to the earth—for the force of gravitation *never* fails. Now, I have here a centre of power which I will not name at present, and when these particles are placed upon it, see what an attraction they have for each other.

Fig. 2.



Here I have an arch of iron filings (Fig. 2) regularly built up like an iron bridge, because I have put them within a sphere of action which will cause them to attract each other. See!—I could let a mouse run through it, and yet if I try to do the same thing with them *here* [on the table] they do not attract each other at all. It is *that* [the magnet] which makes them hold together. Now just as these iron particles hold together in the form of an elliptical bridge, so do the different particles of iron which constitute this nail hold together and make it one. And here is a bar of iron; why, it is only because the different parts of *this* iron are so wrought as to keep close together by the attraction *between* the particles, that it is held together in one mass. It is kept together, in fact, merely by the attraction of one particle to another, and that is the point I want now to illustrate. If I take a piece of flint and strike it with a hammer and break it thus [breaking off a piece of the flint], I have done nothing more than separate the particles which compose these two pieces so far apart, that their attraction is too weak to cause them to hold together, and it is only for that reason that there are now two pieces in the place of one. I will show you an experiment to prove that this attraction does still exist in those particles, for here is a piece of glass (for what was true of the flint and the bar of iron is true of the piece of glass, and is true of every other solid, they are all held together in the lump by the attraction between their parts), and I can show you the attraction between its separate particles, for if I take these portions of glass which I have reduced to a very fine powder, you see that I can actually build them up into a solid wall by pressure between two flat surfaces. The power which I thus have of building up this wall is due to the attraction of the particles, forming, as it were, the cement which holds them together; and so in this case, where I have taken no very great pains to bring the particles together, you see, perhaps a couple of ounces of finely pounded glass standing as an upright wall—is not this attraction most wonderful? *That* bar of iron one inch square has such power of attraction in its particles—giving to it such strength—that it will hold up twenty tons weight before the little set of particles in the small space equal to one division across which it can be pulled apart, will separate. In this manner suspension bridges and chains are held together by the attraction of their particles, and I am going to make an experiment which will show how strong is this attraction of the particles—do not think me a harlequin or fairy. [The Lecturer here placed his foot on a loop of wire fastened to a support above, and swung with his whole weight resting upon it for some moments.] You see, while hanging here all my weight is supported by these little particles of the wire, just as in pantomimes they sometimes suspend gentlemen and damsels.

Now how can we make this attraction of the particles a little more simple? There are many things which if brought together properly will show this attraction. Here is a boy's experiment (and I like a boy's experiment).—Get a tobacco-pipe, fill it with lead, melt it, and then pour it out upon a stone, and thus get a clean piece of lead (this is a better plan than scraping it—scraping alters the condition of the surface of the lead). I have here some pieces of lead which I melted this morning for the sake of making them clean. Now these pieces of lead hang together by the attraction of their particles, and if I press these two separate pieces close together, so as to bring their particles within the sphere of attraction, you will see how soon they become one. I have merely got to give them a good squeeze, and draw the upper piece slightly round at the same time, and here they are as one, and all the bending and twisting I can give them will not make them separate again; I have joined the lead together, not with solder, but simply by means of the attraction of the particles.

This, however, is not the best way of bringing those particles together, we have many better plans than that—and I will show you one that will do very well for juvenile experiments. There is some alum crystallized very beautifully by nature (for all things are far more beautiful in their natural than their artificial form), and here I have some of the same alum broken into fine powder. In it I have destroyed that force of which I have placed the name on this board—COHESION, or the attraction exerted between the particles of bodies to hold them together. Now I am going to show you that if we take this powdered alum and some hot water, and mix them together, I shall dissolve the alum—all the particles will be separated by the water far more completely than they are here in the powder; but then, being in the water, they will have the opportunity as it cools (for that is the condition which favors their coalescence) of uniting together again and forming one mass.

Now having brought the alum into solution, I will pour it into this glass basin, and you will, to-morrow, find that those particles of alum which I have put into the water, and so separated that they are no longer solid, will as the water cools, come together and cohere, and by to-morrow morning we shall have a great deal of the alum crystallized out, that is to say, come back to the solid form. [The Lecturer here poured a little of the hot solution of alum into the glass dish, and when the latter had thus been made warm, the remainder of the solution was added.] I am now doing that which I advise you to do if you use a glass vessel, namely, warming it slowly and gradually; and in repeating this experiment do as I do; pour the liquid out gently, leaving all the dirt behind in the basin; and remember that the more carefully and quietly you make this experiment at home, the better the crystals. To-morrow you will see the particles of alum drawn together, and if I put two pieces of coke in some part of the solution (the coke ought first to be washed very clean and dried), you will find to-morrow that we shall have a beautiful crystallization over the coke, making it exactly resemble a natural mineral.

Now how curiously our ideas expand by watching these conditions of the attraction of cohesion—how many new phenomena it gives us beyond those of the attraction of gravitation. See how it gives us great strength. The things we deal with in building up the structures on the earth are of strength—we use iron, stone, and other things of great strength; and only think that all those structures you have about you—think of the *Great Eastern*, if you please, which is of such size and power as to be almost more than man can manage—are the result of this power of cohesion and attraction.

I have here a body in which I believe you will see a change taking place in its condition of cohesion at the moment it is made. It is at irst yellow, then it becomes a fine crimson red. Just watch when I pour these two liquids together—both colorless as water. [The Lec-urer here mixed together solutions of perchloride of mercury and odide of potassium, when a yellow precipitate of biniodide of mercury fell down, which almost immediately became crimson red.] Now, there s a substance which is very beautiful, but see how it is changing color. It was reddish-yellow at first, but it has now become red. I have previously prepared a little of this red substance, which you see formed n the liquid, and have put some of it upon paper. [Exhibiting several heets of paper coated with scarlet biniodide of mercury.] There it s—the same substance spread upon paper, and there too is the same ubstance; and here is some more of it [exhibiting a piece of paper as large as the other sheets, but having only very little red color on it, he greater part being yellow], a *little* more of it, you will say. Do not be mistaken; there is as much upon the surface of one of these pieces of paper as upon the other. What you see yellow is the same hing as the red body, only the attraction of cohesion is in a certain degree changed; for I will take this red body, and apply heat to it you may perhaps see a little smoke arise, but that is of no consequence), and if you look at it, it will at first of all darken—but see, how it is becoming yellow. I have now made it all yellow, and what s more it will remain so; but if I take any hard substance and rub he yellow part with it, it will immediately go back again to the red ondition. [Exhibiting the experiment.] There it is. You see the ed is not *put back*, but *brought back* by the change in the substance. Now [warming it over the spirit lamp] here it is becoming yellow again, and that is all because its attraction of cohesion is changed. And what will you say to me when I tell you that this piece of common charcoal is just the same thing, only differently coalesced, as the diamonds which you wear. (I have put a specimen outside of a piece of straw which was charred in a particular way—it is just like black lead.) Now, this charred straw, this charcoal, and these diamonds, are all of them the same substance, changed but in their properties as respects the force of cohesion.

Here is a piece of glass [producing a piece of plate glass about two inches square], (I shall want this afterwards to look at and examine its internal condition)—and here is some of the same sort of glass differing only in its power of cohesion, because while yet melted it has been dropped into cold water [exhibiting a "Prince Rupert's drop" (Fig. 3)], and if I take one of these little tear-like pieces and break off ever so little from the point, the whole will at once burst and fall to pieces. I will now break off a piece of this. [The Lecturer nipped off a small piece from the end of one of the Rupert's drops, whereupon the whole immediately fell to pieces.] There! you see the solid glass has suddenly become powder, and more than that, it has knocked a hole in the glass vessel in which it was held. I can show the effect better in this bottle of water, and it is very likely the whole bottle will go. [A 6-oz. vial was filled with water, and a Rupert's drop placed in it with the point of the tail just projecting out; upon breaking the tip off, the drop burst, and the shock being transmitted through the water to the sides of the bottle, shattered the latter to pieces.]

Here is another form of the same kind of experiment. I have here some more glass which has not been annealed, [showing some thick glass vessels (Figure 4)], and if I take one of these glass vessels and drop a piece of pounded glass into it (or I will take some of these small pieces of rock crystal—they have the advantage of being harder than glass) and so will make the least scratch upon the inside, the whole bottle will break to pieces,—it cannot hold together. [The Lecturer here dropped a small fragment of rock crystal into one of these glass vessels, when the bottom immediately came out and fell upon the plate.] There it goes through, just as it would through a sieve.

Fig 3.

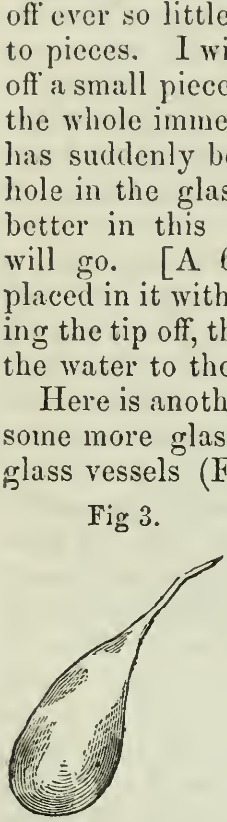
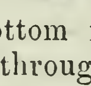


Fig. 4.



Now, I have shown you these things for the purpose of bringing your minds to see that bodies are not merely held together by this power of cohesion, but that they are held together in very curious ways. And suppose I take some things that are held together by this force, and examine them more minutely. I will first take a bit of glass, and if I give it a blow with a hammer I shall just break it to pieces. You saw how it was in the case of the flint when I broke a piece off; a piece of a similar kind would come off, just as you would expect; and if I were to break it up still more, it would be as you have seen, simply a collection of small particles of no definite shape or form. But supposing I take some other thing, this stone for instance (Fig. 5) [taking a piece of mica], and if I hammer this stone I may batter it a great deal before I can break it up. I may even bend it without breaking it; that is to say, I may bend it in *one particular direction* without breaking it much, although I feel in my hands that I am doing it some injury. But now, if I take it by the edges I find that it breaks up into leaf after leaf in a most extraordinary manner. Why should it break up like that? Not because all stones do, or all crystals; for there is some salt—(Fig. 6)—you know what common salt is; here is a piece of this salt which by natural circumstances has had its particles so brought together that they have been allowed free opportunity of combining or coalescing, and you shall see what happens if I take this piece of salt and break it. It does not break as flint did, or as the mica did, but with a clean sharp angle and exact surfaces, beautiful and glittering as diamonds [breaking it by gentle blows with a hammer]; there is a square prism which I may break up nto a square tube. You see these fragments are all square—one side may be longer than the other, but they will only split up so as to form square or oblong pieces with cubical sides. Now, I go a little further, and I find another stone (Fig. 7) [Iceland or calc-spar], which I may break in a similar way, but *not* with the same result. Here is a piece which I have broken off, and you see there are plain surfaces perfectly regular with respect to each other, but it is not cubical—it is what we call a rhomboid. It still breaks in three directions most beautifully and regularly with polished surfaces, but with *sloping* sides, not like the salt. Why not? It is very manifest that this is owing to the attraction of the particles one for the other being less in the direction n which they give way than in other directions. I have on the table before me a number of little bits of calcareous spar, and I recommend each of you to take a piece home, and then you can take a knife and try to divide it in the direction of any of the surfaces already existing. You will be able to do it at once—but if you try to cut it *across* the crystals you cannot; by hammering, you may bruise and break it up—but you cannot divide it into these beautiful little rhomboids.

Fig. 5.

Fig. 6.

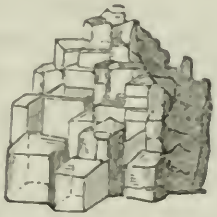
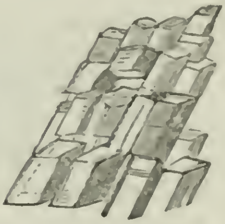
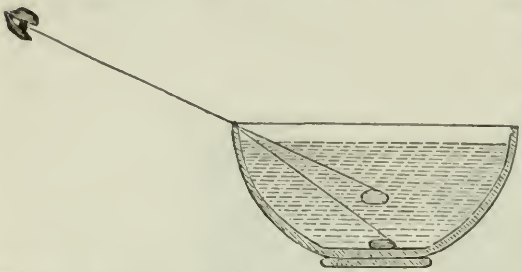


Fig. 7.



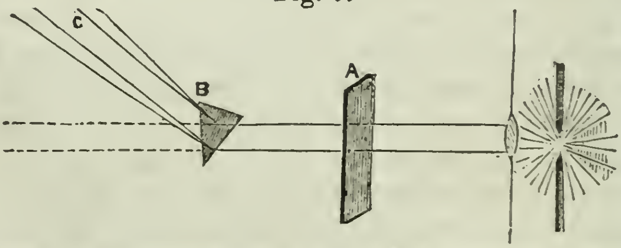
Now I want you to understand a little more how this is—and for this purpose I am going to use the electric light again. You see, we cannot look into the *middle* of a body like this piece of glass. We perceive the outside form, and the inside form, and we look *through* it, but we cannot well find out how these forms become so, and I want you, therefore, to take a lesson in the way in which we use a ray of light for the purpose of seeing what is in the interior of bodies. Light is a thing which is, so to say, attracted by every substance that gravitates (and we do not know anything that does not). All matter affects light more or less by what we may consider as a kind of attraction, and I have arranged (Fig. 8) a very simple experiment upon the floor of the room for the purpose of illustrating this. I have put into that basin a few things which those who are in the body of the theatre will not be able to see, and I am going to make use of this power which matter possesses of attracting a ray of light. If Mr. Anderson pours some water gently and steadily into the basin, the water will attract the rays of light downwards, and the piece of sealing wax will appear to rise up into the sight of those who were before not high enough to see over the side of the basin to its bottom. [Mr. Anderson here poured water into the basin, and upon the Lecturer asking whether anybody could see the silver and sealing wax he was answered by a general affirmative]. Now I suppose that everybody can see that they are not at all disturbed, whilst from the way they appear to have risen up, you would imagine the bottom of the basin and the articles that are in it were two inches thick, although they are only one of our small silver dishes and a piece of sealing wax which I have put there. The light which now goes to you from that piece of silver was obstructed by the edge of the basin when there was no water there, and you were unable to see anything of it; but when we poured in water, the rays were attracted down by it over the edge of the basin, and you were thus enabled to see the articles at the bottom.

Fig. 8.



I have shown you this experiment first, so that you might understand how glass attracts light, and might then see how other substances like rock salt and calcareous spar, mica, and other stones would affect the light; and if Dr. Tyndall will be good enough to let us use his light again, we will first of all show you how it may be bent by a piece of glass (Fig. 9). [The electric lamp was again lit, and the beam of parallel rays of light which it emitted was bent about and decomposed by means of the prism.] Now here you see, if I send the light through

Fig. 9.

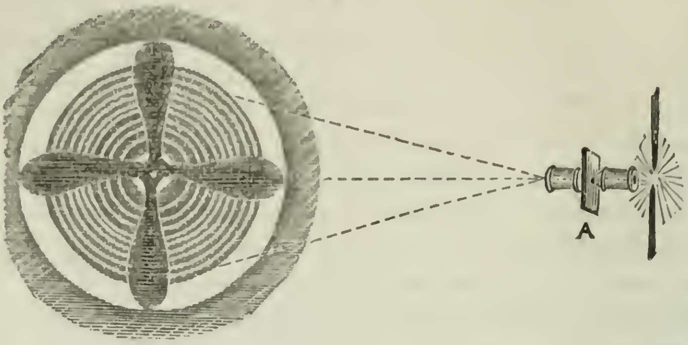


this piece of plain glass A, it goes straight through without being bent (unless the glass be held obliquely, and then the phenomenon becomes more complicated), but if I take this piece of glass B [a prism], you see it will show a very different effect. It no longer goes to that wall but it is bent to this screen C, and how much more beautiful it is now [throwing the prismatic spectrum on the screen.] This ray of light is bent out of its course by the attraction of the glass upon it. And you see I can turn and twist the rays to and fro in different parts of the room just as I please. Now it goes there, now here. [The Lecturer projected the prismatic spectrum about the theatre.] Here I have the rays once more bent on the screen, and you see how wonderfully and beautifully that piece of glass not only bends the light by virtue of its attraction, but actually splits it up into different colors. Now I want you to understand that this piece of glass [the prism] being perfectly uniform in its internal structure, tells us about the action of these other bodies which are not uniform—which do not merely *cohere*, but also have within them, in different parts, different *degrees of cohesion*, and thus attract and bend the light with varying powers. We will now let the light pass through one or two of these things which I just now showed you broke so curiously; and first of all I will take a piece of mica. Here you see is our ray of light—we have first to make it what we call *polarized*, but about that you need not trouble yourselves, it is only to make our illustration more clear. Here, then, we have our polarized ray of light, and I can so adjust it as to make the screen upon which it is shining either light or dark, although I have nothing in the course of this ray of light but what is perfectly transparent [turning the *analizer* round]. I will now make it so that it is quite dark, and we will in the first instance put a piece of common glass into the polarized ray so as to show you that it does not enable the light to get through. You see the screen remains dark. The glass then, internally, has no effect upon the light. [The glass was removed, and a piece of mica introduced.] Now, there is the mica which we split up so curiously into leaf after leaf, and see how that enables the light to pass through on to the screen, and how, as Dr. Tyndall turns it round in his hand, you have those different colors, pink, and purple, and green, coming and going most beautifully;—not that the mica is more transparent than the glass, but because of the different manner in which its particles are arranged by the force of cohesion.

Now we will see how calcareous spar acts upon this light,—that stone which split up into rhombs, and of which you are going to take a little piece home each of you. [The mica was removed, and a piece of calc-spar introduced at A.] See how that turns the light round and round, and produces these rings and that black cross (Fig. 10). Look at those colors, are they not most beautiful for you and for me? (for I enjoy these things as much as you do.) In what a wonderful manner they open out to us the internal arrangement of the particles of this calcareous spar by the force of cohesion.

And now I will show you another experiment. Here is that piece of glass which before had no action upon the light. You shall see what it will do when we apply pressure to it. Here, then, we have our ray of polarized light, and I will first of all show you that the glass has no effect upon it in its ordinary state,—when I place it in the course of the light, the screen still remains dark. Now Dr. Tyndall will press that bit of glass between three little points, one point against two, so as to bring a strain upon the parts, and you will see what a curious effect that has. [Upon the screen two white dots gradually appeared.] Ah! these points show the position of the strain—in these parts the force of cohesion is being exerted in a different degree to what it is in the other parts, and hence it allows the light to pass through. How beautiful that is—how it makes the light come through some parts and leaves it dark in others, and all because we weaken the force of cohesion between particle and particle. Whether you have this mechanical power of straining, or whether we take other means, we get the same result, and, indeed, I will show you by another experiment that if we heat the glass in one part it will alter its internal structure, and produce a similar effect. Here is a piece of common glass, and if I insert this in the path of the polarized ray, I believe it will do nothing. There is the common glass [introducing it]—no light passes through—the screen remains quite dark; but I am going to warm this glass in the lamp, and you know yourselves that when you pour warm water upon glass you put a strain upon it sufficient to break it sometimes—something like there was in the case of the Prince Rupert's drops. [The glass was warmed in the spirit lamp, and again placed across the ray of light.] Now you see how beautifully the light goes through those parts which are hot, making dark and light lines just as the crystal did, and all because of the alteration I have effected in its internal condition; for these dark and light parts are a proof of the presence of forces acting and dragging in different directions within the solid mass.

Fig. 10.



(To be Continued.)

Methods of Ripening Wine.

According to the *Cosmos*, M. Payen, a distinguished French chemist, has the credit of proposing the following methods of ripening wine:

First Method. Take a cask of wine, and expose it to cold in a clean vat; remove every morning, for three or four days successively, the ice which has formed on the surface; the ice, when melted, will furnish *piquette;* and the remaining liquid will be an excellent wine.—Re-pour it into a cask; add to perfume it, say a quart of raspberry juice, or two cents worth of Florence flag-root powdered and first digested in wine, cork it up tight and keep it.—(*If you can.* ED. J. F. I.)

Second Method. In March or April take second-crop hay or straw; make a bed of it about 8 inches thick, upon which lay a first row of bottles corked and waxed; and build up the pile in this way: water the pile with common water so that the hay may ferment, rot, and dissolve. At the end of three or four months your wine will have the same flavor as though it had been three or four years in bottle.

Cosmos, March, 1860.

For the Journal of the Franklin Institute.

Cadmium. By B. Wood, M. D.

The properties of cadmium appear to have been less clearly determined by chemists and metallurgists than those of most other metals. Discrepancies exist in regard to it, while some of its most remarkable, if not most useful properties are not at all noticed, at least by the generality of authors, even when explicit and elaborate as to similar properties possessed by other metals. Our ordinary works on chemistry treat of the metal very briefly, as of little importance—one of the latest says, it "has *no* practical value in the arts:"—but if duly investigated it will be found, I think, to possess qualities highly useful to the arts as well as interesting to science.

The melting point of cadmium is variously stated by authors. Some place it indefinitely, "below a red heat." Overman in his Treatise on Metallurgy, marks it at 550° Fahr., and indicates 600° as the temperature at which the metal volatilizes. Brande, Dict. Science and Art, says "it fuses and volatilizes at a temperature a little below that at which tin melts." Webster, Manual of Chemistry, states that "it melts and volatilizes by a heat not much greater than that required to vaporize mercury." Most of our chemical text-books put its melting point at 442° (from Stromeyer). While the New American Cyclopædia, now in course of publication, places it, on the authority of Daniell, at 360° Fahr.

It would be interesting to determine this accurately. But the heat being too high for measurement by the mercurial thermometer, and having no other, I have only been able to judge approximately by comparative tests. Melted under similar conditions with other metals, I find the metal requires for its fusion nearly the same heat as lead. It s somewhat later in melting but on the other hand it appears to congeal a little the sooner, (which may be due to a difference in the conducting power of the two metals.) I should, therefore, place its meltng point in round numbers at 600° Fahr., that of lead being placed by different authors, at 594°, 600°, and 612°. It volatilizes at a somewhat higher temperature, giving off orange-colored suffocating fumes, which, when inhaled too freely leave a disagreeable, sweetish, styptic sensation upon the *lips*, and an intolerable and persistent brassy taste in the mouth and fauces, with constriction of the throat, heaviness in the head, and nausea.

Of the general properties of cadmium as an ingredient in alloys, Overman, who I believe is high authority in metallurgy, and who, although too broad in some of his conclusions, is more rigidly exact in respect to the individual instances adduced than others that I have had the opportunity of examining, says:

"Cadmium is very soft and malleable and still all its alloys are brittle. Its combinations are not distinguished for fluidity." Again, "The combinations of platinum, copper, and other metals with cadmium, are brittle and hard." The cause of this he ascribes to "its volatile nature and want of affinity," which, recurring to the subject, he accounts for thus:

"When it is melted with any other metal there is a tendency on its part to evaporate; the slight affinity of cadmium for other metals causes a separation of its atoms from those of the other metal, and no intimate union can be formed. If, therefore, the alloy cools there are spaces between the crystals which have been occupied by the expanded atoms of cadmium, and in cooling, these are filled again; this causes brittleness." *Treatise on Metallurgy*, p. 465.

All this is strictly true of *some* of its combinations, such as the particular instances which he cites, although by no means of "all," as will presently be seen.

Other authors, although less explicit, are to a like import, ascribing a similar, general character to the metal, with examples in illustration, and without instancing any exceptions.

In a copy of Article on Alloys of Cadmium, from *Berthier's Traité des Essais*, Tome 2, p. 530, furnished me by the patent office as authority on the subject, I find it stated in general terms that "most of the alloys of cadmium are brittle;" the individual alloys cited are particularly characterized as brittle, and no mention is made of others.—The combination with mercury is thus described: "Cadmium unites with great facility with mercury, even when cold. The amalgam is of a silver white, and texture granular and crystalline. It can be obtained in octohedrons. It is hard and very fragile. Its density is greater than that of mercury. It fuses at 75° [centigrade.] It contains 0·217 of cadmium."

Combined in these proportions the compound will indeed be comparatively fragile; but one might be led to infer from this description that the metals combine in no other proportions. I have seen this particular form of amalgam cited by other authors when speaking of the combination of cadmium with mercury but without any illusion to other compounds of these metals; although they unite with facility in other proportions, forming amalgams particularly noteworthy as contrasted with those of other metals.

While it has been assumed as a general rule as above quoted, that the combinations of cadmium are not distinguished for fluidity, I have not found its fluidifying properties in respect to certain metals and alloys noticed in any work to which I have had access. *Some* of its alloys indeed are *not* remarkable for fusibility but, rather for the reverse; such are its alloys with silver, antimony, and mercury, their melting point being but little lower or even higher than that of the mean of their constituents. But others are much more fusible than the mean, as its alloys with lead, tin, copper, bismuth, zinc. In certain instances it manifests this property in so eminent a degree that it is singular it should not, if known, have been explicitly stated in all professed descriptions of the metal. Bismuth holds a high rank among metals for its property of promoting fusibility in alloys, as is particularly remarked in all chemical text-books, and wherever the metal is treated of, its alloys with lead and tin being specially noted as extraordinary instances. But in some combinations cadmium displays this property more decidedly than even bismuth. The alloy composed of from one to two parts of cadmium, two parts of lead, and four parts of tin is more fusible than the corresponding alloy of two parts (or less) of *bismuth*, two of lead and four of tin. In smaller proportions its superiority is still more marked, requiring much less to produce the same effect, while it does not impair the tenacity and malleability of the alloy but confers hardness and general strength.

As to the brittleness which cadmium is said to communicate when combined with any other metals, the facts are, *some* of its alloys even with malleable metals *are* "brittle." But others are highly tenacious and malleable. Its alloys with gold, platinum, and copper, afford instances of the former. Its combinations with lead, tin, and to a certain extent with silver and mercury, are examples of the latter. An alloy of two parts silver and one of cadmium is perfectly malleable and very hard and strong; with equal parts of each it is also malleable but possesses less tenacity; but when mixed in the proportions of two parts of cadmium and one part of silver, it is brittle. Equal parts of cadmium and mercury form a tough and highly malleable composition; in the proportions of two parts of the latter to one of the former; the amalgam is nearly equal in malleability but possesses less strength. These mixtures are remarkable in view of the fact that most amalgams are exceedingly frail and brittle. A mixture of two or three parts of tin with one part of mercury is so fragile as almost to drop to pieces in handling: the amalgams with lead, bismuth, &c., are similar.

The fusibility of the compounds of cadmium and mercury is nearly that of the mean of their constituents, as indeed, appears to be the case with other amalgams. I do not perceive that mercury acts as a fluidifying agent in alloys—it does not strictly promote fusibility but serves merely to communicate of its own fluidity to the compounds in nearly the ratio in which it is employed; it does not, like cadmium, bismuth, &c., confer any new property in this respect. Being fluid at 39° below the zero of Fahrenheit's scale it will of course if it only retain its own property, reduce the melting point of the compounds into which it enters as an ingredient, below that of the metals with which it is united.

Most of the mixtures of mercury with other metals, although it ma form certain definite compounds with them, indicate combination b simple solution and mechanical admixture rather than by chemical affinity. With cadmium, however, it exhibits a marked affinity, forming amalgams, or as they might be appropriately designated, *alloy* which possess distinctive characters, indicating a true chemical combination.

But I leave these speculations to professed chemists, hoping th points herein referred to may serve to incite attention to a subjec which I think will repay investigation.

Nashville, June 14, 1860.

Specific Gravity of Spirits of Wine.

A Mr. Von Baumhauer has been led by three series of carefully conducted experiments to the conclusion that the densities usually adopted for the mixtures of alcohol and water, from the experiments of Gay-Lussac and others, are incorrect. By his report, it woul seem that every precaution was taken to ensure the purity of th materials and accuracy in the results, and the following are his results as compared with those given by Pouillet. The standard of density is water at its maximum density, and the mixtures were made with absolute alcohol. The temperature was 15° Cent. (59° F.)

Per cent. of alcohol, by volume, in the mixture.	Pouillet.	Density. Experiment	
		First Series.	Second Series.
100	0·7940	0·7939	0·7940
95	·8161	·8119	·8121
90	·8339	·8283	·8283
85	·8495	·8438	·8432
80	·8638	·8576	·8572
75	·8772	·8708	·8708
70	·8899	·8837	·8838
65	·9019	·8959	·8963
60	·9133	·9079	·9081
55	·9240	·9193	·9196
50	·9340	·9301	·9302
45	·9132	·9394	·9400
40	·9515	·9485	·9491
35	·9587	·9567	·9569
30	·9648	·9635	·9636
25		·9692	·9696
20		·9746	·9747
15		·9799	·9800
10		·9855	·9855
5		·9919	·9918
0	·9991	·9991	·9991

Acad. des Sciences, Paris.

Preservation of Yeast.

M. de Changy states that by intimately mixing with any ferment, liquid or solid, a certain quantity of animal or vegetable charcoal, and drying the mixture either in a current of air or by rotation, a powder is obtained which preserves all its fermentable properties for an unlimited time. Beer yeast treated in this way keeps its power for a long time, and the presence of the charcoal in the vat presents more advantages than objections.—*Cosmos.*

*On the Production of Ozone by means of a Platinum Wire made Incandescent by an Electric Current.** By M. Le Roux.

If a platinum wire, not too large, be made incandescent by an electric current in such a manner that the ascending flow of hot air which has surrounded the wire comes in direct contact with the nostrils, an odor of ozone is perceived. The experiment may be made in the following manner:—A very fine platinum wire ($\frac{1}{10}$th to $\frac{1}{25}$th of a millimetre), 20 centimetres long, is taken; it is formed in any shape, and supported in an almost horizontal position in any suitable manner. A glass funnel of 2 or 3 litres is placed over this, so that the air has sufficient access to the wire. As the neck of the funnel is usually too narrow, it is cut so as to leave an aperture 2 or 3 centimetres in diameter, on which is adjusted a glass chimney of a suitable length; the object of which is to cool the gases heated by the wire. The wire is then made incandescent by means of twelve or fifteen Bunsen's cells. The gas issuing from the chimney is found to have the odor of ozone; iodized starch-papers are altered in a few minutes when placed over the chimney. In this case, the air passing over the incandescent wire undergoes a peculiar modification by which it acquires the properties of ozone; but whether this is effected by the electricity acting as a source of heat, or by its own proper action, must be reserved for further experiments.—*Comptes Rendus*, April 2, 1860.

* From the Lond., Edin., and Dub. Philosophical Mag., May, 1860.

Printing Fabrics in Imitation of Embroidery.†

M. Perrot has recently discovered a novel mode of ornamenting fabrics by the printing process, so as to produce an effect similar to embroidery. This process consists simply in printing, by the aid of rollers, any desired pattern upon a fabric, in a solution of gutta percha, previously bleached by the aid of chlorine, and dissolved by any of the well-known solvents. The fabric so printed is then passed through a box or casing containing woolen, cotton, silk, or other fine flock or colored powder, which adheres only to those parts impressed with the solution, and forms beautifully raised patterns and devices having a fine, soft, and velvety surface. This process recalls to our mind a very similar system which was patented as far back as 1850, by Mr. Auchterlonie, of Glasgow. Our readers will find a notice of Mr. Auchterlonie's system in our 3d vol., 1st series, at page 105, where they will be enabled to compare the two, and judge of their relative values. We have not seen any fabrics ornamented after M. Perrot's plan, but

† From the Lond. Practical Mechanic's Journal, May, 1860.

we inspected Mr. Auchterlonie's fabrics, and witnessed the process o ornamenting, and can speak with the greatest confidence of the success of the system.

New and Cheap Motors.

One of the March numbers of the *Cosmos* contains an enthusiasti editorial describing two new machines which are to revolutionize mechanics in France (when the use of the word becomes legal). W copy the substance of these as a specimen of the statements of me who profess the greatest horror of American exaggerations. The firs is a steam-generator somewhat on the Perkins principle of generatin steam by the injection of small quantities of water upon red hot surfaces. As so many persons, and among others so many Frenchmen have done this before, all that the Abbè claims for his friend M Testud de Beauregard, is the tinning the inside and outside of th boiler, and immersing it in a bath of melted tin; but these novelties according to account, produce the following desirable results:—(w translate literally)—"Enormous reduction of bulk of the boiler; enormous diminution of the vaporizing surface; absolute impossibility o explosion; immense diminution in quantity of the feed-water; feed o distilled water from the condensation; no more calcareous scale; n more cleaning, or a simple cleaning with a brush; no more slownes in the boiling; no more waste of time; steam entirely dry without an water carried over; steam whose fixed temperature may be change at pleasure from 200° to 1000°; useful employment of the exhauste steam (*vapeur morte*) for the generation of a new motive force; condensation as perfect as it can be with the production of a vacuum whic adds the atmospheric pressure to that of the steam; a truly extraordinary regularity and stability of working; possibility of doubling tripling, quadrupling, &c., the force obtained at any moment withou any danger; a furnace naturally smoke-consuming whatever combustible is employed; the attending to the boiler made much less laborious these are the incontestible advantages which the tin-bath generator realizes. It is adapted without any increased expense, without any necessity for troublesome or expensive alterations, to all steam engines; it constructors guarantee an economy of 50 per cent. on the fuel befor used by them, however reduced this expense may have before been. Now if a handbill issued by a patentee in America had affirmed one fourth the amount of utter absurdity contained in this extract from journal which we regard as the very best scientific journal in France how long would it be before the editors in France and England ha ceased to denounce American extravagance and credulity?

But this, it appears, is no very great thing after all; a better machin is an explosion engine of M. Lenoir. This is described as a "conical cylinder (*cylindre conique*. The Abbè Moigne plumes himself on his mathematics) with an anterior and posterior compartment separated by a piston similar to those of a steam engine." The gas mixed at the rate of er ct. with 95 of air, is admitted successively at each end and explod- d by a spark from a small induction machine; thus blowing the piston ack and forward. All this is well enough and old enough, but look at he results:—"With 5 per cent. of gas and 95 of air, the shaft and fly- heel made 120 turns; the force produced was fully that of a horse ower. A stout man operating on the circumference of the fly-wheel ould not stop it; a mass of iron on the shaft was cut by the gouge or hisel without trouble. With this speed of 120 turns for twelve hours, he expenditure of gas is three cubic metres (106 cubic feet). Estimat- ng the cubic metre at 6 centimes ($1\frac{1}{5}$ cents) the expense per horse power er hour would be a centime and a half, that is about one-half that of he same force from coal.

It will be seen that gas is cheaper in Paris than here, but what is hat to what follows. "We applaud with great pleasure the marvel- ous use which M. Isoard has made of superheated steam united with oal tar, to generate at an excessively low price, and as rapidly as is ished, torrents of very rich lighting gas. If we are not mistaken, he new gas will cost less than a centime per metre cube ($56\frac{1}{2}$ cents er thousand cubic feet), and as it requires only three cubic metres for horse power for 12 hours; this force which in the most privileged ountries, *in the county of Cornwall, near the mouth of the mines*, (when id the English coal mines get into Cornwall?) still costs five centimes 1 cent) will cost at Paris but one-fourth of this."

By the way, is not this the Saunders' Patent which has just exploded ere, after a temporary notoriety obtained by means similar in char- cter to these, but of less brilliancy?

In the same journal we find the following appreciation of the modi- cation of Rhumkorff's Induction Apparatus by Ritchie, of Boston:

"An American physicist had brought to Paris an induction machine f a form somewhat differing from that adopted by M. Rhumkorff, and f larger dimensions, which, when excited by a sufficient battery, gave continued series of sparks truly frightful, 13 inches long and more, nd snapping with a formidable noise, less like electric discharges than ke thunder-bolts. The professors and physicists who saw it in opera- on at M. Jules Duboscq's were astonished; it threw the apparatus of ne celebrated artist into the shade, and for a moment it might be be- eved that they had been surpassed. M. Jamin, the Professor at the Po- technic school, who was anxious to enrich the collections of that estab- shment with an extraordinary induction machine, gave a sort of chal- nge to M. Rhumkorff; he threatened to purchase the American achine, if within a very short interval he did not produce as power- ul a one. M. Rhumkorff accepted the challenge, and his new appa- atus, which costs less than half that of the American, is still more owerful; the sight of his sparks, or of his thunder-bolts, causes the oldest to tremble; with 6 couples of Bunsen, the sparks extend to ne enormous distance of $16\frac{1}{2}$ inches."

Now, omitting this extravagance about the thunder-bolts and terrors, hich is unworthy of a serious writer on Science, let us establish the acts upon which the story is based. Prof. McCulloh, of Columbia

College, N. Y., took out with him one of Mr. Ritchie's instruments Up to this time M. Rhumkorff had never got a spark over 3 inche in length; nor had Mr. Hearder, who improved Rhumkorff's instrument in England, got over 6. Mr. Ritchie's instrument is operate by 3 cells of a Bunsen battery, and the largest form (which we believ to be the one taken over by the Professor) is capable of giving spark 18 inches in length.

M. Rhumkorff had (we believe) 6 months given him to produce hi competing machine, and was allowed to examine Mr. Ritchie's instrument and even to dissect it; Mr. Ritchie never having attempted an secrecy as to the differences between the original instrument and wha he modestly called a modification, although it is in some respects entitled to be considered a new instrument. If, then, M. Rhumkor has not done better with 6 cups of battery than Ritchie has done wit 3, the Abbé had better reserve his eloquence for future endeavors.

City Telegraph.

J. Herpin proposes to establish throughout Paris a system of telegraphs by which messages may be easily and rapidly sent from on part of the city to another. This would be a great convenience an a great benefit for business men. The proposed tariff is very cheap For a simple message; by day, 2 cents; by night, from midnight t 6 A. M., 4 cents: message and answer, 3 cents by day, 5 cents by night He calculates the probable yearly profits of the enterprise at $200,000 besides the employment given to laborers, lame and feeble persons women, &c.—*Cosmos.*

*Transparent Ivory.**

The process for making ivory transparent and flexible is simpl immersion in liquid phosphoric acid, and the change which it undergoes is owing to a partial neutralization of the basic phosphate of lim of which it principally consists. The ivory is cut in pieces not thicke than the twentieth part of an inch, and placed in phosphoric acid o a specific gravity of 1·131, until it has become transparent, when i is taken from the bath, washed in water, and dried with a clean line cloth. It becomes dry in the air without the application of heat, an softens again under warm water.—*Druggists' Circular.*

* From the Lond. Chemical News, No. 16.

Self-Registering Hygrometer.

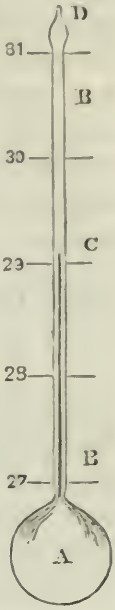
MM. Midre and Chaviere have improved the common hair hygrometer of Saussure by adding to it two loose hands, which are move by a pin from the main index, so as to register maxima and minima The improvement is very simple, but none the worse for that.

Cosmos

Description of an Hermetically-sealed Barometer.* By Richard Adie, Liverpool.

When mounted on an ivory scale, this instrument resembles in size ,nd portability a pocket thermometer of the medium or larger class.

It is constructed from a piece of thermometer tube, in which, in lieu ıf the spherical or cylindrical bulb formed for a thermometer, a cistern is made in the form of the section of a cylinder, 1·4 nches diameter and 1-10th of an inch thick, varying these neasures according to circumstances; but generally the bulb ıas nearly the shape and dimensions of a half-crown. On he top of the tube there is an air cavity similar to that used n Dr. Rutherford's registering thermometer.



A. The cistern containing alcohol.
BB. The tube in which the height corresponding to the barometer is read.
C. The top of the alcohol column.
D. The air-cavity for correcting for temperature.
31 to 27. The figures to represent the height of the column C, with reference to the mercurial column.
Sub-divisions between each inch are added so as to read off to ·02.

The influence of change of temperature is got rid of by trial and adıustment of each instrument; so that the expansion of the air in the ıpper cavity will counterbalance the expansion of the liquid in the cistern. This correction for temperature applies only to the condition ıf equal heating of the instrument throughout. When it is well done, ın instrument is obtained, which is extremely sensitive to any change ıf atmospherical pressure.

If dipped in water at the temperature of the air, the column in the ube immediately rises to show the increase of pressure. When car·ied from one story of a house to another, the change is noticed as the tairs are ascended. In the beginning of last April, I put one of the arometers in the corner of the compartment of the railway carriage n which I was traveling, from Liverpool to Edinburgh, where it indi·ated regularly the extensive changes from the sea level which that ine of route contains.

The hermetically-sealed barometer which I have found to work best, s filled with colored alcohol; the column in the tube moving through ıbout 1·5 inches for every inch of the mercurial barometer.

Filled with mercury, instruments corrected for temperature were btained to move through half an inch for every inch of the barometer; ut, in point of mobility, they were much inferior to alcohol-filled tubes.

Filled with ether, an instrument corrected for temperature could ıot be obtained in combination with delicacy of indication; but if the correction for temperature be dispensed with, and a place can be found for the barometer where the changes of temperature are small. ether, in an hermetically-sealed tube of the kind described, would furnish a most minute measure of changes in atmospheric pressure.

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* From the Lond. Quar. Jour. of the Chemical Society, April, 1860.

A tube filled with water did not act with delicacy, from the want o mobility in the fluid.

In the hermetically-sealed barometer, the reading may be much disturbed by unequal heating, when the instrument is held in the hand or the sun allowed to shine on a portion of it. This can in a degree be prevented by the skill of the observer, with the interposition o non-conductors, and when carried by holding the instrument suspended by a cord, rather than keeping it in the pocket or hand. When the indication has been disturbed by unequal heating, it must remain suspended fifteen or twenty minutes before a reliable reading can be made.

Thin Cast Iron. By Wm. Fairbairn, Esq., F. R. S., &c., President, in the Chair.

From the Lond. Chemical News, No. 19.

The President exhibited two large pans of cast iron, procured by Mr Worthington from China, where they are used for boiling rice. The metal, which is at the strongest part only one-tenth of an inch in thickness, possessed considerable malleability. The President remarked that the art of making such large castings of thin metal, was unknown in England.—*Proc. Manchester Lit. and Philo. Soc.*

Electro Copies of Engraved Steel Plates. By Henry Bradbury.

From the Journal of the Society of Arts, No. 389.

Sir:—Through the medium of the *Journal of the Society of Arts,* in July last, I made known the result of my endeavors to deposit pure nickel upon the surface of engraved copper plates. This I have continued to do with marked success. The deposit has nearly the appearance of silver in color, possesses almost the hardness of iron, is free from oxidation by air, resists the action of the ordinary acids, and, being easy of manipulation and inexpensive, is well worthy of attention. Each coating will furnish 5000 impressions and upwards. It is so hard as to stand the free use of the burnisher, and its texture is so fine as not to show the worn away portions of the deposit after each successive coating.

Finding the deposit so beautifully fine in texture and polished in surface, it occurred to me that if an engraved steel plate were covered with such a deposit, the plate might safely be immersed in a solution of sulphate of copper, and a metallic matrix be produced direct from it, without the risk of injury from the action of the acid of the solution. I have tried this with complete success, and have found (as might be supposed) that an electro copy of a steel plate thus obtained is very superior to one made from a matrix of gutta percha or other plastic composition. The engraved plate, however, must be quite free from under-cut lines.

12 and 13 Fetter Lane, Fleet Street, May 2, 1860.

Fusion of Platinum.

M. H. Sainte-Claire Deville continues to announce his fusion of pla- inum as though there were something new in it. In this city it has een worked in this way in large masses for years, by Mr. Bishop, ormerly assistant to Dr. Hare. And, by the way, as Prof. Deville ontinues to find the density of iridium 18. it is evident that his fusion f that metal must be very imperfect, for Drs. Hare and Boyè found 1·8, and the latter was not free from air-bubbles. Iridium is, there- ore, the heaviest metal yet known.

Clarifying Coal Oils.

From the Lond. Chemical News, No. 16.

Messrs. Dumoulin and Cotelle have been making a series of expe- iments with a view of rendering heavy oils suitable for ordinary ighting purposes, and have succeeded in producing a magnificent ight, free from smoke and smell, and adapted in all respects for burn- ng in a room. The following is their process:—In a close vessel are laced 100 lbs. of crude coal oil, 25 quarts of water, 1 lb. of chloride f lime, 1 lb. of soda, and half a pound of oxide of manganese. he mixture is violently agitated and allowed to rest for 24 hours, hen the clear oil is decanted and distilled. The 100 lbs. of coal oil re to be mixed with 25 lbs. of resin oil; this is one of the principal oints in the manipulation: it removes the gummy parts from the oil nd renders them inodorous. The distillation spoken of may termi- ate the process, or the oils may be distilled before they are defecated nd precipitated.—*Le Génie Industriel.*

n the Composition of Water obtained from the Coal-strata, Bradford Moor, Yorkshire. By F. A. Abel, Esq.

From the Lond. Ed. and Dub. Phil. Mag., May, 1860.

The analysis of a sample of water from the above source was un- ertaken a short time since with the view to ascertain whether it was dapted to general domestic purposes. The results furnished by the xamination appeared of sufficient interest to warrant their publica- ion.

Two samples of the water collected at the mouth of a coal-pit, at n interval of about one month (the separate analyses of which fur- ished thoroughly concordant results), were submitted to me officially or examination by Lieutenant-Colonel Hamley, Commanding Royal ngineer at York, who informed me that the water, which is highly steemed in the neighborhood for drinking and culinary purposes, is aised from coal-pits, at a depth of about 200 feet beneath Bradford oor—an abundant and regular supply being obtained.

The specific gravity of the water was 1000·78 at 60° F. Its re- ction was powerfully alkaline, and its flavor was brisk and agreeable.

The proportion of solid matter obtained on evaporation amounted to 44·1 grains in an imperial gallon, of which by far the largest proportion consisted of carbonate of soda.

The alkalinity of the boiled water was determined by means of standard sulphuric acid, and found to be equivalent to a proportion of 30·76 grains of carbonate of soda in an imperial gallon.

The result obtained by the direct determination of the carbonic acid, corresponded accurately to the proportion required by theory to hold in solution the whole of the lime and magnesia in the water, and to form bicarbonate with the amount of soda represented by the number above quoted.

The following statement represents the proportions of the various constituents existing in solution in an imperial gallon of the water:—

Bicarbonate of soda,	43·53
Sulphate of soda,	7·50
Chloride of sodium,	1·34
Sulphate of potassa,	0·31
Phosphate of lime,	trace.
Carbonate of lime,	1·90
Carbonate of magnesia,	0·80
Organic matter,	1·20

Carbonic acid, holding the carbonates of lime and magnesia in solution, 1·25 grain = 2·642 cubic inches at 60° F.

The absence of nitric acid, ammonia, silicic acid, alkaline sulphides, and oxide of iron was established by special examinations.

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*A Composition named Zeiodelite, a kind of Paste which becomes as hard as Stone, is unchangeable by the Air, and being proof against the action of Acids, may replace Lead and other substances for various uses.** JOSEPH SIMON, 1859.

Zeiodelite is made by mixing together 19 ℔s. of sulphur and 42 ℔s. of pulverized stoneware and glass. The mixture is exposed to a gentle heat, which melts the sulphur, and then the mass is stirred until it becomes thoroughly homogeneous, when it is run into suitable moulds and allowed to cool. This preparation is proof against acids in general, whatever their degree of concentration, and will last an indefinite time. It melts at about 120° Centigrade, and may be re-employed without loss of any of its qualities, whenever it is desirable to change the form of an apparatus, by melting at a gentle heat and operating as with asphalte. At 110° Centigrade it becomes as hard as stone, and therefore preserves its solidity in boiling water. Slabs of zeiodelite may be joined by introducing between them some of the paste heated to 200° Centigrade, which will melt the edges of the slabs, and when the whole becomes cold it will present one uniform piece. Chambers lined with zeiodelite in place of lead, the inventor says, will enable manufacturers to produce acids free from nitrate and sulphate of lead. The cost will be only one-fifth the price of lead. The compound is also said to be superior to hydraulic lime for uniting stone, and resisting the action of water.

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* From the Lond. Chemical News, No. 14.

For the Journal of the Franklin Institute.

Particulars of the Steamer Kilauea.

Hull built by Paul Curtis. Machinery by Atlantic Works, Boston, Mass. Owners, C. A. Williams & Co. Intended service, at the Sandwich Islands.

Hull.—Length on deck, 130 ft. 8 ins. Breadth of beam (molded), 26 ft. Depth of hold, 10 ft. Do. to spar deck, 16 ft. 6 ins. Frames—molded, 13 ins.—sided, 12 to 14 ins.—apart from centres, 30 ins., and strapped with diagonal double braces, $3\frac{1}{2} \times \frac{3}{8}$ in. Draft, forward and aft, 10 ft. Tonnage, 398 tons. Area of immersed section at load draft of 10 ft., 225 sq. ft. Masts, two—Rig, Brigantine.

Engines.—Vertical direct-acting. Diameter of cylinder, two of 26 ins. Length of stroke, 3 ft. Maximum pressure of steam, 25 lbs. Cut-off, ordinarily one-fourth. Maximum revolutions at above pressure, 55.

Boiler.—One—Return flue. Length, 28 ft. Breadth, 7 ft. 9 ins. Height, exclusive of steam chimney, 8 ft. 9 ins. Number of furnaces, two. Breadth do., 3 ft. 4 ins. Length of grate bars, 6 ft. 3 ins. Number of flues, above, 4, below, 10. Internal diameter do., above, 1 ft. 6 ins., below, 8 of 10 ins. and 10 of 18 ins. Length do., above, 22 ft. 8 ins., below, 15 ft. 11 ins. Diameter of smoke pipe, 3 ft. 3 ins.

Propellers.—Diameter of screw, 9 ft. Length do., 3 ft. 6 ins. Pitch do., 21 to 23 ft. Number of blades, three.

C. H. H.

Specification of a Patent granted to Barnabas Wood, of Davidson County, State of Tennessee, for an Improved Alloy or Metallic Composition suitable for a Metallic Cement in the manufacture of Tin, Pewter, and other metals; also useful for casting and other purposes.—Dated March 20th, 1860.

The object of my invention being to produce an alloy possessing great fusibility in connexion with the requisite tenacity and malleability suited for certain uses; I effect this object by the employment of cadmium in suitable proportions in combination with certain proportions of lead and tin: by which means I have produced an alloy which is superior to others in use in respect to the joint qualities above mentioned, and which, as a metallic cement or solder in fabricating wares from certain metals, is an improvement upon all others. It is claimed as an improvement upon the ordinary solders especially for soldering metals consisting essentially of tin, such as pewter and other of the more fusible combinations of tin employed in the arts; and in general in all those cases which require an easily melted, and highly tenacious and malleable solder.

It consists of the following proportions, which may be somewhat modified in various ways without substantially modifying the result, to wit:

Cadmium from one to two parts; lead two parts; tin four parts; the result as to fusibility and tenacity being nearly identical whether the cadmium be used in the larger or smaller ratio.

This alloy possesses great strength and tenacity, is perfectly malleable, and melts at a temperature somewhat under 300° F., being some 50° or 60° below the melting point of the most fusible mixture of lead and tin used for solder; and is not inferior in other qualities. And in the essentials of tenacity and malleability it is superior to any of the so-called "bismuth solders" which melt at as low a temperature. Its qualities render it likewise superior to any other alloy for casting and modeling purposes, in certain cases, as will be at once evident to those versed in the business.

The specimen marked "No. 3" forwarded Oct. 31st, 1859, consists of one part cadmium, one part lead, and two and a half parts tin. Of the additional specimens, No. 4 contains two parts cadmium, two lead, and four tin; and No. 5, one part cadmium, two parts lead, and four tin.

For greater fusibility to suit particular cases, mercury may be added, although its tendency is, especially if used in large proportion, to impair the quality of tenacity, according as it improves that of fusibility. But it may be used in quantity at least equal to that of the cadmium without sensible detriment, while three or even four times that amount will not so destroy the useful qualities of the composition but that it may be used to advantage as a solder for certain cases, thereby lowering its melting point to nearly the temperature at which water boils.

The greatest fusibility is obtained when cadmium is used in the proportions of the formula above named, or in the ratio of one-fourth to one-eighth of the joint quantity of lead and tin; but I do not confine myself to this ratio, as the cadmium, for economy, may be considerably reduced, say to one-tenth or one-twelfth of the other two metals, without materially diminishing this quality of the alloy for practical use.

Cadmium may be used upon the same principle to improve the ordinary tinner's solder also called "fine solders," consisting essentially of tin alloyed with lead in the proportion of about one part lead to two or three parts tin; being used in the ratio aforesaid in respect to the sum of these metals, thereby conferring greater fusibility than a like ratio of bismuth, without, like bismuth, impairing the qualities of tenacity and malleability.

The same holds in respect to the combinations of lead, tin, and bismuth, or "bismuth solders" in the more fusible forms of which, the use of cadmium, according to the same principle, will produce results not hitherto obtained, and of decided benefit.

In particular, those mixtures of lead, tin, and bismuth which melt at, or somewhat under, the temperature of boiling water, and which in consequence of this extreme fluidity are known by the common name of "fusible metal," may, by the means indicated, be greatly improved in this quality without detriment to other useful qualities—the use of cadmium in any form in these mixtures to an amount equal to one-fourth, or one-eighth of the amount of lead and tin in them producing about the greatest attainable fusibility; although to insure the best results in respect to other qualities, as tenacity and pliability, it is better to use a little more lead and less tin than stated in the usual formulas of "fusible metal." I generally use the following proportions where the greatest fusibility is required, to wit:—cadmium one to two parts, tin two parts, lead four parts, bismuth seven to eight parts; the alloy in these proportions melting at about 160° F., being some 40° or 50° below the melting point of the said "fusible metal" and not inferior in other qualities for the purpose of a metallic cement. The specimen marked "No. 1", contains the larger proportion of cadmium, consisting of cadmium 56 parts, tin 59 parts, lead 103½ parts, bismuth 212 parts, being combined according to the chemical equivalents of the ingredients, conceiving the union to be more intimate and perfect—although subsequent experiment has not demonstrated any practical advantage to result from such nice adjustment of proportions.

When the cadmium constitutes from one-tenth to one-twelfth of the joint amount of lead and tin, the melting point will be about 170° or 180° F., being low enough for general use in most cases.

These proportions may be somewhat varied without materially modifying the result. The proportions of cadmium and bismuth remaining the same, those of the lead and tin may be greatly varied in respect to each other, provided they jointly hold a similar ratio to the whole. Thus for greater softness the lead may be employed in a much greater excess over the tin than stated in the formula, and for greater hardness and rigidity, the tin may preponderate over the lead.

This alloy may be used as a cement for very fusible alloys, such as the "white metal" used for bells, the *cliché* of the French, and the so-called "fusible metal" above named; also for light wares of pewter, &c., and as a convenient temporary cement; also for light castings requiring a more fusible material than the bismuth alloys; not being liable to the objections appertaining to the amalgams resorted to in such cases.

Its melting point may be lowered by adding mercury, which, in quantity equal to one or two parts of the cadmium, is less objectionable than in alloys without cadmium.

For greater tenacity with a melting point similar to that of the "fusible metal" before mentioned, a larger proportion of lead should be used, so that this metal shall equal or somewhat exceed the quantity of bismuth.

My mode of compounding the ingredients possesses nothing peculiar; they may be melted all together and mixed by stirring, or melted separately and poured together. I usually melt the cadmium and lead together in one vessel, and the tin, or tin and bismuth, in another, pouring them together when melted, and mixing thoroughly by pouring the whole a few times from vessel to vessel. Mercury when used is added to the melted alloy, mixing as before.

Nor is my manner of using the composition peculiar. The parts of the metals to be cemented are touched with a solution of chloride of zinc, and the solder applied as usual, and fused by the application of heat in any of the ordinary modes. In casting, when used for taking casts or moulds from other fusible metals, these should be brushed over with black lead, lamp black, India ink, or other pigment, to prevent adhesion. A solution of logwood or red sanders in alcohol is very convenient for the purpose.

I do not claim the combination of lead and tin, or of lead, tin, and bismuth, in the proportions specified, nor any other, separate and apart from cadmium. Nor do I claim any results that have been produced by any of the combinations referred to apart from cadmium, whether that of fusibility or any other, nor any merely equivalent results that may have been hitherto produced by other combinations. I do not claim the use of cadmium as an alloy, or as an ingredient in alloys, to be any thing new, nor its use in connexion with any of the metals specified for the purpose of producing any results in alloys other than those described. I confine myself to its use in the ratio substantially as specified in combination with the metals herein specified in the proportions of the said metals substantially as set forth, so as to produce an improvement in alloys whether in the qualities of fusibility and tenacity jointly, or of either (separately), but without practical detriment to the other, so as to produce a better article for use as a metallic cement, and for certain other uses.

What I therefore claim as my invention is,

The composition of matter, or alloy, consisting of the following proportions of cadmium, lead, and tin, or any modification thereof substantially as indicated so as to produce a similar result in alloys, to wit: cadmium from one to two parts, lead two parts, tin four parts, possessing the properties and advantages as herein described, and that may be used as a metallic cement, and for other purposes, and to which also mercury may be added, as set forth, to modify the result for particular cases.

I also claim as a further application of the same principle embodied in the production of the aforesaid alloy, the composition of matter or alloy consisting of from one to two parts cadmium, two parts tin, four parts lead, and seven or eight parts bismuth, or any modification thereof as herein specified and indicated so as to produce an alloy as described, useful as a cement and for other purposes as set forth, and to which also mercury may be added as stated.

What I claim as new in either case being the herein specified improvement in alloys produced by using cadmium in the ratio and manner herein described, in combination with the metals specified in the proportions thereof substantially as set forth.

AMERICAN PATENTS.

AMERICAN PATENTS ISSUED FROM MAY 1, TO MAY 31, 1860.

Air Engine,—Compressed	Dana Bickford,	Westerly,	R. I.	15
Amalgamator,	J. A. Brock,	Chicago,	Ill.	1
Auger,—Hollow	Nye and Haviland,	Elmira,	N. Y.	22
Axle Boxes,	H. L. Castile,	Memphis,	Tenn.	15
———,—Making	A. E. Smith,	Brouxville,	N. Y.	8
Ballot-box,	G. L. Bailey,	Portland,	Me.	22
Bands for Machinery,	J. H. Clifton,	Newcastle,	Penna.	22
Bark Mills,	William Tansley,	Salisbury Cent.	N. Y.	29
Barometers,	H. A. Clum,	Auburn,	"	29
Barrels,—Tools for Opening	David Snedeker,	City of	"	8

Basket,	J. K. Park,	Marlboro',	Mass.	1
Bayonet Scabbards,—Manuf. of	Emerson Gaylord,	Chicopee,	"	15
————,—Frog for	William Hoffman,	Solano co.,	Cal.	8
Bed Bottom,	L. W. Buxton,	Nashua,	N. H.	8
Bedstead Fastening,	Richard Hubbard,	Milton,	Ind.	15
————	Purches Miles,	New Haven,	Conn.	15
————,—Folding	Edward Cotty,	Brooklyn,	N. Y.	1
Bedsteads,—Invalid	A. W. Chase,	Ann Harbor,	Mich.	15
Bee-hives,	J. S. Black,	Bloomfield,	Ky.	15
Beer Powders,	John McKellar,	Thomaston,	Me.	15
Bill of Fare,	William A. Bury,	Grosse Isle,	Mich.	8
Billiard Table Pocket-irons,	J. P. Ellicott,	Washington,	D. C.	1
——— Tables,—Chalk-holder	"	"	"	22
Boats,—Suspending	C. H. Hasker,	Portsmouth,	Va.	29
Bolt,—Flush	William R. Carnes,	Roxbury,	Mass.	22
Bonnet Frames,—Clamp for	H. A. Reynolds,	City of	N. Y.	1
Bonnets,	A. Henri,	Louisville,	Ky.	1
Book-binding,	Thomas Towndrow,	City of	N. Y.	29
Boot and Shoe Soles,—Burnish.	E. T. Ingalls,	Haverhill,	Mass.	8
————,—Fill'g for	E. N. Foote,	Saratoga Spr's,	N. Y.	1
Boots & Shoes,—Jointed Tip for	G. A. Mitchell,	Turner,	Me.	22
————,—Skiv. Counters	W. A. Bacon,	Campello,	Mass.	29
————,—Wooden Soles	Alexander Hanvey,	Steubenville,	Ohio,	1
Bosom Expanders,	Church and Ellsworth,	Birmingham,	Conn.	8
Brushes,	William Tusch,	Brooklyn,	N. Y.	22
Brush,—Hair	J. R. Ingersoll,	City of	"	22
Buildings,—Machine for Moving	Samuel Wells,	Elmore,	Ohio,	22
Butt Hinge,	J. E. Shields,	Washington,	D. C.	29
Butter,—Machine for Printing	Miller and Wiegand,	Philadelphia,	Penna.	22
——— Worker,	Lydia W. Stiles,	Brooklyn,	Ohio,	15
Camp Stool,	J. W. Willett,	Wareham,	Mass.	22
Canal Locks,—Gates for	S. J. Seely,	Albany,	N. Y.	8
Cane Juice,—Defecating	E. H. Wheeler,	New Orleans,	La.	8
Canals,—Auto. Draw-bridges for	G. C. Bovey,	Chillicothe,	Ohio,	8
Candle Mould Boxes,	G. A. Stanley,	Cleveland,	Ohio,	8
——— Moulding Apparatus,	"	"	"	8
Cane Juice,—Clarifying	P. Marcelin & E. Eude,	New Orleans,	La.	22
Caoutchouc,—Vulcanizing	S. W. Warren,	City of	N. Y.	22
Caps,—Forming Seamless Felt	J L Bridge & W B Lodge,	Vernon,	"	8
——,—Making Sheet Metal	Orrin Newton,	Pittsburgh,	Penna.	22
Car Brakes,	H. A. Mears,	Pecatonica,	Ill.	1
————	E. F. Jewett,	Plainville,	Ohio,	1
—— Couplings,	J. S. Vaughan,	Alexandria,	Va.	22
—— Seats,	C. A. McEvoy,	Richmond,	Va.	8
—— Springs,	William Kingsbury,	City of	N. Y.	8
—— Wheels,	S. P. Smith,	Troy,	"	29
—— Windows,—Sash-support,	H. K. Smith,	Philadelphia,	Penna.	29
Cars for Transport'g Cattle, &c.,	Lee Swearingen,	Valley Riv. F's,	Va.	29
Carpet-cleaner,	H. L. Nichols,	City of	N. Y.	22
Cattle,—Apparatus for Breachy	J. P. Ledy & W. Boyers,	Mt. Carroll,	Ill.	15
Cement,	Horace Billings,	Beasdstown,	"	1
————	Charles Fricke,	Mobile,	Ala.	1
————	"	"	"	29
Cements,—Silicated	G. E. Vanderburgh,	Mamaraneck,	N. Y.	29
Chimney Cowl,	George Millard,	Waterbury,	Conn.	15
Churn,	W. B. Gordinier,	Coudersport,	Penna.	8
————	R. G. Holmes,	Worcester,	Mass.	8
————	G. H. Van Vleck,	Buffalo,	N. Y.	8
————	J. W. Evans,	Forsyth,	Ga.	29
————	D. M. Woodin,	Brandon,	Wis.	29
Cigars,—Machines for Making	Thomas Thorp,	City of	N. Y.	1
Clocks Vertically,—Adjusting	J. F. Keeler,	Cleveland,	Ohio,	1

Cloth,—Machinery for Drying	Bezaleel Sexton,	Albany,	N. Y.	8
Clothes-frame,	J. Fraser,	Rochester,	"	15
Coffins,	Carter and Jones,	City of	"	29
Coke,—Desulphurizing	George Nock,	Pittsburgh,	Penna.	29
Corn Planters,	William C. Banks,	Como Depot,	Miss.	1
——— ———	"	"	"	1
——— ———	Amos Seaman,	Winnebago co.,	Ill.	1
——— ———	J. H. Bonham,	Elizabethtown,	Ohio,	22
——— ———	A. Hayes & J. Vancuren,	Chenoa,	Ill.	22
——— ———	Joel Lee,	Galesburgh,	"	22
——— ———	B. T. Stowell,	Quincy,	"	22
——— ———	John Johnson,	Naples,	"	29
——— ———	J. C. Moore,	Peoria,	"	29
—— Shellers,	J. G. Putnam,	Tioga,	Penna.	22
Cotton,—Machines for Cleaning	John Gilmore,	New Orleans,	La.	22
——— Bales,—Iron Ties for	Walter Stewart,	Natchez,	Miss.	1
——— ——— ——— ———	Wm. S. Loughborough,	Rochester,	N. Y.	8
——— ———,—Locks for	A. P. Merrill, Jr.,	Natchez,	Miss.	22
——— ———,—Metal Ties for	James Aiken,	"	"	1
——— Presses,	Y. F. Wright,	Green Hill,	Ga.	1
——— ———	M. M. Jones,	Morrisville,	N. Y.	15
——— Seed Planters,	N. E. Badgley,	Gadsden,	Ala.	1
Counter Shaft,—Arrangement of	G. W. Davis,	Brooklyn,	N. Y.	22
Couplings for Shafting,	Samuel Hall,	City of	"	29
Cow-milkers,	L. O. Colvin,	Cincinnatus,	"	22
——— ———	"	"	"	29
Cultivator Teeth,	D. B. Rogers,	Pittsburgh,	Penna.	8
Cultivators,	John Neff, Jr.,	Pultney,	N. Y.	8
———	R. P. Van Horne,	Gratiot,	Ohio,	29
———,—Hand	D. C. Jordan,	Center Port,	N. Y.	22
Cup and Stand,—Metallic	S. J. Ladd,	Providence,	R. I.	8
Curtain Fixture,	J. F. Hall,	Bangor,	Me.	22
Dentists,—Moulds for metal dies,	F. Y. Clark,	Savannah,	Ga.	22
Digging Machines,	A. A. Garver,	Mechanicsb'gh,	Penna.	22
Ditching Machines,	Benedict and Cummings,	W. Springfield,	"	15
——— ———	C. O. West and others,	Martinsville,	Ohio,	15
——— ———	John Masters,	Waukegan,	Ill.	22
Door Fastener,	John Lightfoot,	Cold Spring,	Ky.	8
—— Latch,	R. L. Underhill,	Bath,	N. Y.	22
—— Lock,	Henry Lockwood,	City of	"	1
—— Plate,—Glass	Montague & Townsend,	New Bedford,	Mass.	22
Drain Tiles,—Mode of Laying	H. F. Baker,	Centreville,	Ind.	1
Drains,—Cement	Benjamin Livermore,	Hartford,	Vt.	1
Dress Hook,	J. W. Strange,	Bangor,	Me.	8
Drill,—Hand	J. H. Parker,	Boston,	Mass.	15
———	"	"	"	15
Dumb-bells,	D. F. Savage,	"	"	29
Dumping Wagons,	Tolhurst and Sartwell,	Liverpool,	Ohio,	8
Egg-beater,	Frederick Ashley,	City of	N. Y.	1
Elastic Cloth,—Manufacture of	H. H. Day,	"	"	29
Electrodes,—Insulator for	Engler and Krauss,	Paris,	France,	15
Embroidery Sewing Stand,	Dana Bickford,	Westerly,	R. I.	1
Engraving Rollers,—Mach's for	William Shields,	Manchester,	Engl'd,	15
Evaporating Apparatuses,	Isaac Sherman,	Cleveland,	Ohio,	22
——— ———	T. J. Price,	Industry,	Ill.	15
——— Liquids,	Ernst Constantine,	City of	N. Y.	8
——— ———	George Stevenson,	Zionsville,	Ind.	8
Fat,—Machines for Cutting	J. M. Hunter,	City of	N. Y.	8
Fats into Fatty Acids,—Decom.	R. A. Tilghman,	Philadelphia,	Penna.	15
Feathers,—Renovating	O. J. Pennell,	Williamsport,	"	29
Felloes,—Machines for Bending	Arthur Hemenway,	Cleveland,	Ohio,	1

Felling Trees,	Pomeroy Johnson,	Whitney's Pt.,	N. Y.	15
Ferules,	T. W. Detray,	Montpelier,	Vt.	29
Fertilizers,	Lemuel Stephens,	Philadelphia,	Penna.	8
————,—Mach's for Sowing	R. J. Hill,	Americus,	Ga.	29
Filters,	L. S. Chichester,	City of	N. Y.	29
Filtering Apparatus,	J. H. G. D. Wagner,	Paris,	France,	29
Fire Arms,—Hammer Guards	Benjamin Singleton,	Portsmouth,	Va.	1
————,—Repeating	W. H. Elliott,	Plattsburgh,	N. Y.	29
————————	"	"	"	29
————,—Revolving	Savage and North,	Cromwell,	Conn.	15
————————	A. J. Gibson,	Worcester,	Mass.	22
Fire-escape,	Frederick Seymour,	Cincinnati,	Ohio,	1
————	Baker and McGill,	City of	N. Y.	22
————	Leonard King,	Bridgeport,	Conn.	22
————	Louis Knocke,	Davenport,	Iowa,	22
————	Albin Warth,	City of	N. Y.	29
————	Henry Powelson,	N. Brunswick,	N. J.	29
Fire-place,	Alfred Carson,	City of	N. Y.	22
Fire-proof,—Rendering Safes	A. K. Eaton,	Brooklyn,	"	29
Flock,—Machinery for Cutting	J. Tilton & E. Riston,	Northfield,	N. H.	15
Flues,—Construction of	R. F. O'Brien,	Boonville,	Mo.	15
Fruit and Vegetable Cutter,	W. H. Trissler,	Lima,	Ind.	22
Furnaces,	R. R. Taylor,	Reading,	Penna.	8
————,—Hot-air	Jacob Stuber,	Utica,	N. Y.	1
————,—Feeding Sawdust to	J. P. Wigal,	Henderson,	Ky.	8
Gasaliers,	J. W. Kerr,	Pittsburgh,	Penna.	22
Gas,—Apparatus for Generating	A. K. Tupper,	Milford,	Mich.	22
—— Burners,	G. W. Thompson,	City of	N. Y.	1
—— Retorts,	Charles Wooster,	"	"	22
————,—Securing Lids	J. R. Thomas,	Williamsburgh,	"	29
Gates,	S. H. Sill,	Geneva,	"	8
Gate Pulley,	David Bedell,	Seneca Falls,	"	8
Girders,—Iron Truss	J. W. Murphy,	Philadelphia,	Penna.	8
Glass,—Grinding & Polishing	Albert Broughton,	City of	N. Y.	29
Governor Valves,	G. H. Timmerman,	St. Louis,	Mo.	1
Grain Binding Machines,	Daniel W. Ayres,	Middleport,	Ill.	22
—— Cleaners,	P. C. Fritz,	Barrytown,	N. Y.	1
————————	W. W. Webster,	Foxville,	Va.	1
—— Scales,	Charles Hunter,	Indianapolis,	Ind.	8
—— Separators and Cleaners,	Wm. M. Amall,	Sperryville,	Va.	1
—— Weighing Machines,	Lovett Eames,	Kalamazoo,	Mich.	15
Grate,—Coal	W. T. McMillen,	St. Louis,	Mo.	22
Grinding Surfaces,—Pig Metal	Thaddeus Selleck,	Greenwich,	Conn.	1
Grist Mills,	Charles Badger,	Edgerton,	Wis.	22
Gun Stocks,	C. R. Alsop,	Middletown,	Conn.	22
Hair,—Picking Curled	William Adamson,	Philadelphia,	Penna.	29
Halters,	Lewis Whitehead,	Nunda,	N. Y.	1
Hame Tugs,	Jacobs Hovey,	Bedford,	Mich.	8
Harrows,—Seeding	M. S. Root,	Medina,	Ohio,	22
Harvesters,	S. T. Bruce,	Marshall,	Mo.	1
————	W. A. Kirby,	Buffalo,	N. Y.	15
————	Stoler and Sisson,	Bristol,	Penna.	15
————,—Guard Fingers for	G. W. Slough,	Canton,	Ohio,	8
————,—Raking Attach. for	W. H. Wilson,	Denton,	Md.	8
Harvesting Machines,	J. A. Wagner,	Pultney,	N. Y.	22
Hat Bodies,—Felting,	M. R. Lemman,	Columbus,	Miss.	8
Heating Apparatus,—Steam	L. W. Leeds & C. Vaux,	City of	N. Y.	29
————————	G. W. Richardson,	"	"	29
———— Buildings,—Boiler for	C. F. Hitchings,	"	"	15
Hemp Brakes,	John Mills, Jr.,	Quincy,	Ill.	29
Hoisting Machinery,	R. A. Wilder,	Cressona,	Penna.	1
———— Persons,—Machines for	I. H. Hobbs,	Philadelphia,	"	15

Hollow Ware,—Spin'g Metallic	John Grey,	Pittsburgh,	Penna.	1
Hominy Mills,	Heatwole & Mauck,	Harrisonburgh,	Va.	1
Hook Catch for Doors,	C. B. Richards,	Brooklyn,	N. Y.	8
Hooks and Eyes,	D. M. Smith,	Springfield,	Vt.	22
Hoops,—Locks for Metal Bale	C. A. Dubs,	Natchez,	Miss.	8
———,—Machine for Splitting	S. F. Atherton,	Fitchburgh,	Mass.	1
Horse Powers,	Glidden & Starkweather,	Alvaretta,	Wis.	29
——— Shoes,	R. A. Goodenough,	Brooklyn,	N. Y.	29
Horses' Feet,—Cushion for	Loren Hall,	Milford,	Mass.	29
Hose,—Machines for Rubber	T. J. Mayall,	Roxbury,	"	15
——,—Manufacture of Rubber	"	"	"	22
—— Coupling,	S. W. Warren,	Brooklyn,	N. Y.	8
—— Tubing,	H. A. Alden,	Matteawan,	"	8
——————,—Rubber	T. J. Mayall,	Roxbury,	Mass.	22
——————,—Flexible,	H. A. Alden,	Matteawan,	N. Y.	22
Hydrants, &c.,—Valves for	M. C. Meigs,	Washington,	D. C.	22
Hydraulic Motor,	Wm. Kennish,	London,	Engl'd,	15
———— Presses,	C. W. Flippen,	Laurel Grove,	Va.	8
Ice Cream Freezers,	G. W. Davis,	New Orleans,	La.	22
————————	C. W. Packer,	Philadelphia,	Penna.	22
————————	G. W. Brown,	City of	N. Y.	29
—— Pitcher,	N. F. Griswold,	Meriden,	Conn.	1
India Rubber Goods,—Finishing	Trotter & Williams,	City of	N. Y.	22
Ink Reservoir for Pens,	R. B. Fitts,	Philadelphia,	Penna.	8
Iron,—Restoring Burnt	G W Morris & W Quann,	"	"	1
Kettle Ears,—Making	Morris Wells,	Brooklyn,	N. Y.	8
Keys,	James Deally,	Louisville,	Ky.	29
——,—Attaching Bows to	E. L. Gaylord,	Terrysville,	Conn.	29
Key-holes,—Guards for	T. G. Harold,	Brooklyn,	N. Y.	29
Knives,—Sharpening Cylind.	J. H. and A. T. Goodell,	City of	"	1
Knitting Machines,	Eli Tiffany,	Thompsonville,	Conn.	1
———————	John Chantrell,	Bristol,	"	15
———————	W. H. McNary,	Brooklyn,	N. Y.	15
Lamps,	John Stuber,	Utica,	N. Y.	1
———	Octave Saulay,	New Orleans,	La.	8
———,—Vapor,	M. V. B. Buel,	Buffalo,	N. Y.	1
——————	T. G. Clayton,	Washington,	D. C.	15
——————	I. W. Pettibone,	Norfolk,	Conn.	15
——————	J. H. Rollins,	Wapello,	Iowa,	15
——————	Albertus Geiger,	Dayton,	Ohio,	29
——————	S. W. Lowe,	Philadelphia,	Penna.	29
——————	T. S. Ray & A. C. Rand,	Buffalo,	N. Y.	29
———————,—Burners for	Emil Trittin,	Philadelphia,	Penna.	15
———————,—Generators for	S. D. Baldwin,	Milwaukie,	Wis.	8
Lanterns,	J. D. Brown,	Cincinnati,	Ohio,	29
Laps,—Machinery for Winding	J. E. Cheney,	Lowell,	Mass.	15
Lasting Machines,	W. Wells,	Boston,	"	1
Lathes,	J. M. Scribner,	Middleburgh,	N. Y.	15
Leather,—Machines for Finish'g	W. P. Martin,	Salem,	Mass.	1
————,—————— Stretch'g	J. H. Haskell,	Baltimore,	Md.	15
Lifting Jacks,	Wm. Clare Anderson,	St. Louis,	Mo.	15
Locks,	Lyman Derby,	City of	N. Y.	8
Lock,	Andrew Rankin,	Philadelphia,	Penna.	22
Locks for Traveling Bags,	Bourne & Cunningham,	City of	N. Y.	1
Locomotive Boilers,	John Thompson,	East Boston,	Mass.	29
Looms,	Tillotson Clarkson,	South Adams,	"	1
———	J. H. Clifton,	Newcastle,	Penna.	29
———,—Harness Frames for	James Greenhalgh, Sr.,	Pascoag,	R. I.	15
———,—Narrow-ware	Benjamin Hardy,	City of	N. Y.	1
Lozenges,—Machines for Cut'g	W. J. McClelland,	"	"	8
————,—————— Mak'g	Gottfried Kober,	"	"	22

Mainsails of fore-and-aft vessels,	G. W. Geran,	Brooklyn,	N. Y.	22
Marine Charts,—Bearings, &c.,	E. R. Knorr,	Washington,	D. C.	1
——— Propeller,	Eldridge Weber,	Gardiner,	Maine,	29
Measuring Tapes,	O. W. Minard,	Waterbury,	Conn.	1
Meat Chopper,	C. B. Beeker,	Lancaster Co.,	Penna.	8
—— Cutter,	Purches Miles,	New Haven,	Conn.	22
Mechanical Movements,	J. H. Wait,	Portsmouth,	Ohio,	15
Millstones,—Cementing	Samuel Hoyt,	Wilmington,	Del.	1
————,—Dress for	John Broughton,	City of	N. Y.	22
————,—Hanging	J. H. Glover,	Glasgow,	Ky.	22
————————	G. P. Dance.	Columbia,	Texas,	29
Mills,—Plates to	Stephen Hull,	Poughkeepsie,	N. Y.	22
Mill Races,—Floating Sluices	M. A. Shepard,	Parkersburgh,	Ill.	8
Moulding,	John Dougherty,	Cold Spring,	N. Y.	15
Mouldings,—Machine for Cut'g	J. B. Winslow,	Charlestown,	Mass.	29
Mop Wringer,	Orville Choate,	Morrisville,	Vt.	15
Motion,—Converting	Louis Planer,	City of	N. Y.	22
Mousing Hook,	S. G. Coleman,	Providence,	R. I.	1
Mowing Machines,	A. M. George,	Nashua,	N. H.	1
Mowing and Reaping Machines,	Richard Ketchum,	S. Dansville,	N. Y.	15
Musical Instrument,	Aloys White,	New Haven,	Conn.	8
———— Instruments,—Reed	George Woods,	Boston,	Mass.	8
———— Reeds,	J. C. Briggs,	Woodbury,	Conn.	1
Nut Cracker,	S. J. Smith,	City of	N. Y.	15
Oils obtained from Coal,	Luther Atwood,	City of	N. Y.	29
——,—Condensing Coal	J. F. Bennett,	Pittsburgh,	Penna.	29
——,—Distilling Coal	H. W. Adams,	Brooklyn,	N. Y.	29
——,—Re-distillation of Coal	Luther Atwood,	City of	“	15
——, &c.,—Furnace for Coal	James Calkin and others,	Hudson,	“	8
Ordnance,—Breech-loading	Wm. W. Hubbell,	Philadelphia,	Penna.	29
————————	“	“	“	1
Ores,—Machines for Crushing	Wm. P. Parrott,	Boston,	Mass.	1
Ovens,	Duncan McKensie,	Brooklyn,	N. Y.	1
Ox Shoes,	A. Van Valkenburgh,	Griffin's Corners,	“	8
— Yoke Fastenings,	Wm. N. Lockwood,	New Britain,	Conn.	22
Paint,—Machines for Mixing	Brown & Banker,	Boston,	Mass.	15
Paper,—Preparation of	J. L. Jullion,	Aberdeen,	Gr. Brit.	8
—— Bag Machine,	S. E. Pettee,	Philadelphia,	Penna.	29
——————	G. F. Lufbery,	City of	N. Y.	8
—— File,	Elisha Clark,	“	“	8
———	Adolphus Liebenroth,	“	“	22
——,—Safety	M. A. Howell, Jr.,	Ottawa,	Ill.	22
—— Stuff,—Boilers for	C. S. Buchanan,	Ballston Spa,	N. Y.	1
Peach Parer,	Marvin Smith,	New Haven,	Conn.	15
Pegging-machine Jack,	Walter Fitzgerald,	Boston,	Mass.	22
Pessaries,	J. M. Heard,	Aberdeen,	Miss.	29
Piano-fortes,	J. A. Gray,	Albany,	N. Y.	1
Piano-forte Action,	Wm. Compton,	City of	“	22
——————	G. H. Hulskamp,	Troy,	“	22
Pictures,—Mouldings for Hang'g	Henry Hochstrasser,	Philadelphia,	Penna.	8
Pile Fabrics,—Manufacture of	Noble Hill,	Caton,	N. Y.	29
Pipes,—Molds for Cement	Henry Knight,	Jersey City,	N. J.	8
——,—Moulding Iron	Wm. Doyle,	Albany,	N. Y.	15
Pipe,—Making Sheet Metal	C. T. Boardman,	Bergen Point,	N. J.	8
—— Wrench,	Wm. F. Beecher,	Chicago,	Ill.	1
Ploughs,	J. H. Gooch,	Oxford,	N. C.	8
———	J. S. Willson,	Waynesboro',	Ga.	8
———	Wm. C. Pitts,	Austin,	Texas,	15
———	Wood & Byrington,	Byron,	Ill.	15
———	J. S. Huggins,	Timmonsville,	S. C.	22
———	I. N. Rankin,	Middletown,	Iowa,	22

Ploughs,	Rhodes & Skaggs,	Talladega,	Ala.	22
———	C. I. Shiver,	Camden,	S. C.	22
———,—Clevis for	Calvin Adams,	Pittsburgh,	Penna.	22
———,—Cultivating	Allen Hughes,	Gratiot,	Ohio,	29
———,—Mold-boards for	H. H. Scoville,	Syracuse,	N. Y.	29
———,—Spade	Elijah Harris,	Princeton,	Ill.	22
Plough Stocks,	J. A. Boyd,	Jackson Co.,	Fla.	1
Pointers,—Perforating Rule for	Wm. H. Harding,	Philadelphia,	Penna.	1
Post Butt,	James Holland,	Conshohocken,	"	15
Potato Diggers,	John Bawden,	Freehold,	N. J.	8
———	Elijah Robertson,	Hartford,	Conn.	8
———	David Niven,	Rochester,	N. Y.	15
———	Carolus Dunham,	Batavia,	"	22
Powder Flasks,	G. W. Whipple,	West Acton,	Mass.	1
Preserve Cans,	Theodore Sellers,	E. Birmingham,	Penna.	22
———	Wm. H. Harn,	Carlisle,	"	22
———	A. T. Twing and others,	Lansingburgh,	N. Y.	22
Printers Composing Stick,	S. W. Brown,	Syracuse,	"	22
Printers,—Roller Boxes for	H. J. Spiller,	Cincinnati,	Ohio,	29
Printers Rule,—Tool for Miter'g	Grover & Pelouse,	Middletown,	N. Y.	29
Printing Addresses on Papers,	Noah Bowles,	"	Md.	1
Prisons,—Window Grating for	Edwin May,	Indianapolis,	Ind.	29
Presses,—Power	Charles Oyston,	Little Falls,	N. Y.	22
———	James Weed,	Muscatine,	Iowa,	22
Propellers,—Applying Steam to	A. M. Sawyer,	Athol,	Mass.	8
Prunes,—Curing	Isaac Reckhow,	Brooklyn,	N. Y.	22
Pumps,	George Lindsay,	Petersburgh,	Va.	1
———	J. E. Atwood,	Bucksport,	Maine,	8
———	Walter Peck,	Rockford,	Ill.	8
———	Washburn Race,	Seneca Falls,	N. Y.	22
———	J. M. Stephenson,	Anderson,	Ind.	22
———	G. H. Mills,	East Boston,	Mass.	22
Quartz,—Machinery for Crush'g	J. C. Dickey,	Saratoga Sp'gs,	N. Y.	8
Raft,—Life-saving	S. B. Broad,	City of	N. Y.	8
Railroads,—Rails for Street	George Eaton,	Boston,	Mass.	1
Railroad Cars,—City	W. C. Allison,	Philadelphia,	Penna.	29
———,—Journals for	Humphrey Jackman,	Elizabethport,	N. J.	1
———,—Propelling	Busser & Harmer,	Philadelphia,	Penna.	8
———,—Ventilator for	Asa Hapgood,	Worcester,	Mass.	22
——— Chairs,	I. W. Wetmore,	Erie,	Penna.	15
——— Jacks,	F. H. Furniss,	Cleveland,	Ohio,	15
Ranges,—Cooking	F. S. Merritt,	City of	N. Y.	1
———, &c.,—Water-backs for	W. S. Mayo,	"	"	1
Ratan Machine,	Liveras Hull,	Charlestown,	Mass.	29
Reels,—Silk or Thread	S. W. and J. F. Palmer,	Auburn,	N. Y.	15
Rice Hullers,	I. M. Hendricks,	Philadelphia,	Penna.	29
—— and Clover Hullers,	Stephen Burrows,	Whitewater,	Wis.	8
Rifle Canes,	Andrew Crow,	Middlefield,	Mass.	8
Rocking Chair,	H. J. Coster,	Chicago,	Ill.	8
——— into a Cradle,	R. H. Ewing,	Nicollet Co.,	Minn.	8
Rotary Engines,	A. F. Reeder,	Bloomington,	Ill.	15
Ruffles,—Manufacture of	G. B. Arnold,	City of	N. Y.	8
Saccharine Juices,—Evaporat'g	L. P. Harris,	Mansfield,	Ohio,	29
———	A. C. Clemens,	Crain township,	"	22
Salt,—Manufacture of Common	Thomas Spencer,	Syracuse,	N. Y.	29
Sash-fastener,	J. M. Whitney,	Astoria,	"	15
———	Ross Johnson,	Baltimore,	Md.	29
Sausage Filler,	Amos Shepard,	Southington,	Conn.	22
——— Machine,	J. G. Perry,	S. Kingston,	R. I.	15
Saw-set,	A. L. Currier,	Washington,	D. C.	15
Saw Teeth,—Machine for Cut'g	Frederick Shuttee,	Philadelphia,	Penna.	29

Saws,—Machine for Filing	Patrick McMahon,	Scottsville,	N. Y.	1
——,—Hanging Reciprocating	Charles Weston,	Salem,	Mass.	8
Screw Plates,	Z. L. Jacobs,	Hebron,	Conn.	15
Seeding Machines,	W. J. Baker,	Dimock,	Penna.	8
————————	A. E. Doty,	N. Henderson,	Ill.	22
————————	David Eldred,	Monmouth,	"	22
————————	A. Kirlin,	New Boston,	"	22
————————	S. T. Holly,	Rockford,	"	29
————————	J. R. Turner,	Jacksonville,	"	8
Seed Planters,	W. C. Pitts,	Austin,	Texas,	15
—————	Ephraim Russell,	Coatsville,	Penna.	15
—————	J. W. Masten,	Utica,	Mich.	22
Sewing Machines,	J. S. McCurdy,	Brooklyn,	N. Y.	1
————————	G. B. Arnold,	City of	"	8
————————	Birdsill Holly,	Lockport,	"	8
————————	E. E. Bean,	Boston,	Mass.	8
————————	George Little,	City of	N. Y.	15
————————	Samuel Hoffman,	Richmond,	Va.	22
————————	J. N. Chamberlin,	Troy,	N. Y.	29
————————	Hamilton Ruddick,	Boston,	Mass.	29
Shaving Cup,	T. E. Hughes,	Birmingham,	Penna.	1
Shears,—Rotary Cutting	C. W. Brown,	Boston,	Mass.	22
Sheathing Felt,—Manufacturing	J. B. Hyde,	Newark,	N. J.	29
Shingle Machines,—Feed'g Bolt	N. S. Gilbert,	Albion,	N. Y.	8
Shoe Plate,	T. W. Porter,	Bangor,	Maine,	8
Shoemakers Float,	F. L. Langley,	Troy,	N. Y.	15
Shot and Shells,—Moulding	David Huestis,	Cold Spring,	"	15
Shovels,—Manufacture of	S. D. Nelson,	Pittsburgh,	Penna.	15
Shovel and Tongs,—Combinat.	J. W. Evans,	Forsyth,	Ga.	15
Shutters,—Metallic Rolling	J. B. and W. W. Cornell,	City of	N. Y.	15
Signal Apparatus,	T. T. Woodward,	S. Reading,	Mass.	15
Silicates,—Preparation of	G. E. Vanderburgh,	Mamoraneck,	N. Y.	29
Skates,	John Lovatt,	Newark,	N. J.	29
———	Wm. Scarlett,	Aurora,	Ill.	29
———,—Wheel	Reuben Shaler,	Madison,	Conn.	29
Sliver Machines,	F. T. Grant,	Gardiner,	Maine,	29
Smut Machines,	G. B. Turner,	Cuyahoga,	Ohio,	1
Snow or Ice into Large Blocks,	Harris Morse,	Columbia,	Cal.	15
Soil,—Breaking and Pulverizing	R. J. Gatling,	Indianapolis,	Ind.	29
Spinning Yarn,—Machinery for	J. E. Crowell,	Chelsea,	Mass.	8
——————————————	Edmund Victory,	Watertown,	"	8
Spirit Levels,	W. T. Nicholson,	Providence,	R. I.	1
Spring Balances,—Compensat'g	O. S. Squyer,	West Dresden,	N. Y.	8
Starch,—Machinery for Clean'g	C. S. Irwin,	Madison,	Ind.	15
Steam Boiler Feeders,	Sanderson & Stanton,	Syracuse,	N. Y.	15
————— Furnaces,	D. H. Williams,	Alleghany,	Penna.	15
————— Regulator,	C. A. Wilson,	Cincinnati,	Ohio,	1
——— Boilers,—Alarm Valves	Selah Dustin,	Detroit,	Mich.	8
————————,—Safety Valve,	W. Mt. Storm,	City of	N. Y.	1
————————,—Sediment Col.	J. T. Price,	Rockville,	Ind.	15
————————,—Therm. Cases	G. E. Hayes,	Buffalo,	N. Y.	8
——— Engines,	John Randall,	Elmira,	"	8
—————————,—Air Pumps	D. A. Woodbury,	Rochester,	"	8
—————————,—Slide Valves	Andrew Buchanan,	Jersey City,	N. J.	15
—————————,—Governors	G. W. Rains,	Newburgh,	N. Y.	29
—————————,—Gov. Valves	Wm. Chambers,	Muscatine,	Iowa,	1
——— Traction Engines,	J. F. Holloway,	Saline Mines,	Ill.	29
——— Gauges,	E. G. Allen,	Boston,	Mass.	1
——— Generators,—Coal Oil in	Thomas Shaw,	Philadelphia,	Penna.	29
Stills,—Construct. Condensers of	Patrick Mihan,	Boston,	Mass.	15
Straw Cutters,	N. Edwards & E. G. Day,	Chittenden Co.,	Vt.	1
Stoves,	Samuel Shadbolt,	Scottsville,	N. Y.	8
———	J. C. Henderson,	Albany,	"	29

Stoves,	J. G. Treadwell,	Albany,	N. Y.	15
———,—Cooking	J. C. Henderson,	"	"	1
Stove Grates,	Edward Mingay,	Boston,	Mass.	1
Sugar,—Machine for Drying	A. W. J. Mason,	New Orleans,	La.	8
——,—Appa's for Cut'g Loaf	Kinzler & Rosebrock,	City of	N. Y.	8
—— Juices,—Evaporating	Charles Harvey,	Richmond,	Ind.	8
Swift,	C. P. S. Wardwell,	Lake Village,	N. H.	15
Syringes,—Enema	F. B. & B. L. Richardson,	Boston,	Mass.	8
Table Fork,	Wm. Mannheimer,	City of	N. Y.	1
Telegraphic Machines,	Jedediah Weiss,	Bethlehem,	Penna.	15
——— Instruments,	A. G. Holcomb,	City of	N. Y.	15
Threshing Machines,	D. S. Wagner,	Penn Yan,	"	1
Tire,—Cooling and Setting	Permin Kopfer,	Fond du Lac,	Wis.	29
——,—Shortening	Abraham Voorhees,	Grand Rapids,	Mich.	22
——,—Shrinking	S. S. Greene,	Rome,	N. Y.	29
Tobacco Presses,	T. N. Read,	Aspen Wall,	Va.	22
Toy Cannons,	J. O. Couch,	Middlefield,	Conn.	1
Troughs,—Making Rain,	Wm. H. Henderson,	Franklin,	Ind.	22
Trunk Lock,	S. Bourne, Jr.,	City of	N. Y.	1
Tube Joints,—Making	S. I. Hayes,	Chicago,	Ill.	29
Tweer,	Alanson Ordway,	Stratham,	N. H.	15
Type,—Machine for Setting	C. W. Felt,	Salem,	Mass.	29
Valve Cocks,	Nickerson & Colton,	Athens,	Ga.	8
Vapor Burners,	Wm. N. Brown,	Camden,	N. J.	15
Vegetable Slicer,	S. T. Sanford,	Fall River,	Mass.	22
Veneers,—Mosaic	Heinigke and Laemmel,	Bay Ridge,	N. Y.	29
Vise,	T. B. Lamb,	Summit,	Mich.	22
Voltaic Gas Batteries,	Maurice Vergnes,	City of	N. Y.	15
Wagon Shaft Shackle,	J. B. Thorp,	Plantsville,	Conn.	1
Walls,—Construc. of Concrete	S. T. Fowler,	Brooklyn,	N. Y.	1
Washing Machine,	Ingraham & Rounds,	Berlin,	Wis.	8
————	E. D. Thomas,	Rochester,	N. Y.	8
————	J. S. Pond,	Cleveland,	Ohio,	15
————	"	"	"	22
————	Mark Richardson,	Philadelphia,	Penna.	22
————	Clark Roberts,	Winchester,	Ill.	22
————	A. Leightheiser,	Reading,	Penna.	29
————	S. W. Woodward,	Buffalo,	N. Y.	29
Water Elevator,	Maximilian Wappich,	Sacramento,	Cal.	29
——— from Wells,—Elevating	Billings & Hutton,	Cleveland,	Ohio,	22
——— Heating Appa's—Valve	J. E. Boyle,	Brooklyn,	N. Y.	1
——— Wheels,	G. H. Jones & J. Brown,	Rose,	"	1
————	Lyman Gibson,	Elmira,	"	1
————	A. M. Swain,	Lowell,	Mass.	15
Window Sashes,—Hanging	Thomas Fry,	Brooklyn,	N. Y.	15
Windlasses,	S. D. Avery,	Norwich,	"	8
Wind-mills,	E. W. Mills,	Amber,	"	1
————	W. J. Tustin,	Benicia,	Cal.	22
Wood,—Machines for Bundling	W. L. Williams,	City of	N. Y.	8
——,—Preparing & Moulding	Philander Shaw,	Boston,	Mass.	15
Wool,—Removal of Burrs from	C. L. Harding,	Winooski Falls,	Vt.	29
Wrench,	G. B. Phillips,	Newark,	N. J.	15
Wrenches,—Rolling Shanks of	L. and A. G. Coes,	Worcester,	Mass.	8
Wringing Clothes,	J. H. Clark,	Westbrook,	Maine,	8
Writing Desk,	Elisha Hughes,	McCartysville,	Cal.	1
Yards to Topmasts,—Attachm't	Samuel Hall,	Boston,	Mass.	22
——,—Hanging Topsail	James Nute,	East Boston,	"	22

EXTENSIONS.

Sugar Pans,	Alfred Stillman,	City of	N. Y.	22
Wood Screws,—Manufacturing	T. W. Harvey,	"	"	29

ADDITIONAL IMPROVEMENTS.

Fire Arms,—Revolving .	E. D. Newbury, .	Albany,	N. Y.	1
Protractor, .	Josiah Lyman, .	Lenox,	Mass.	15
Tenons on Spokes,—Cutting	Mahlon Gregg, .	Philadelphia,	Penna.	15
Washing Machine,	Charity Pendleton,	Galena,	Ill.	29

RE-ISSUES.

Bells,—Hanging .	G. W. Hildreth, .	Lockport,	N. Y.	1
Bonnet Frames, .	W. E. Kidd, .	City of	"	15
Burglars Alarms, .	Wilson & Thomas, .	Frankfort,	"	22
Corn Huskers, .	D. M. Mefford, .	Jeffersonville,	Ind.	15
Curtain Fixtures, .	Lewis White, .	Hartford,	Conn.	22
Gas,—Heating or Cooking by	W. F. Shaw, .	Boston,	Mass.	29
Harvesters, .	C. B. Brinckerhoff, .	Batavia,	N. Y.	22
————,—Grain and Grass	C. Aultman & Co.,	Canton,	Ohio,	1
————————	" .	"	"	1
Iron Pavement,—Cellular	Titus & Des Granges,	St. Louis,	Mo.	1
Kettles,—Grinding Cast Iron	C. C. Bradley, Jr., .	Syracuse,	N. Y.	1
Knitting Machines, .	Tompkins & Johnson,	Troy,	"	15
Ranges,—Cooking	H. H. Stimpson, .	Boston,	Mass.	1
Steam Boilers,—Prev. Incrust. of	H. F. & L. F. Knoderer,	Chillicothe,	Ohio,	15
Stoves,—Coal .	C. Eddy & J. Shavor,	Troy,	N. Y.	8
Sugar,—Machine for Cut'g Loaf	A. & F. Brown, .	City of	"	1
Sugar Mould Carriages,	C. E. Bertrand, .	Williamsburgh,	"	29
Water-proof Leather Goods,	Samuel La Forge, .	Cleveland,	Ohio,	15
Wheel Hubs,—Casting Boxes	Thomas Ellis and others,	Philadelphia,	Penna.	1

DESIGNS.

Spoon and Fork Handles,	M. Gibney, .	City of	N. Y.	15
Stove, .	J. Greer & R. I. King,	Dayton,	Ohio,	15
——— Plates, .	Hubbell & Wood, .	Buffalo,	N. Y.	15
Stoves, .	Jacob Resor, .	Cincinnati,	Ohio,	15
Stove Plate, .	J. Siddons & J. C. Hart,	Rochester,	N. Y.	15
Stoves,—Parlor .	Wm. W. Stevens,	Portland,	Maine,	15

FRANKLIN INSTITUTE.

The Committee on Science and the Arts constituted by the Franklin Institute of the State of Pennsylvania, for the promotion of the Mechanic Arts, to whom was referred for examination—"A method of Lighting Gas by the Electric Spark invented by Mr. Arch. Wilson, of the City of New York,"

Report:—That the apparatus proposed by Mr. Wilson for this purpose, consists, first, in an insulator applied to every burner which is to be lighted, so as to cut off all electric communication between the burner and the gas-pipe; secondly, in the establishment of proper electric conductors between the burners thus insulated; and thirdly, in bringing the ends of the conducting wire into communication with the poles of one of Ritchie's Induction Apparatus, by means of which a spark may be caused to pass at each break in the circuit.

First; the insulator consists at present of a piece of hard india-rubber screwed on to the top of the gas-pipe, into the upper end of which the burner in its turn is screwed. Over this insulator is slipped a loop of copper wire, one end of which is turned upwards and bent so as to present its end immediately over the opening of the burner; the loop is also connected with a copper wire which passes to the next preceding burner. It will be seen that when this arrangement is completed, if an electric current be passed over the wire sufficiently powerful to overcome the resistances at the breaks, a spark will pass from the end of each wire, through the air above the opening, to the burner, and from the first burner will pass to the next, and so in succession generating a spark at each opening of the circuit. But to effect this, very considerable tension will be required in the current.

Secondly; the wires are arranged in such order, passing from the Ritchie to the wire above the first burner; then from this burner to the wire above the second, &c.; that (including the spark passage across the air from the wires to burners) there is a single electric communication made by bringing the first and last wires into communication with the poles of the Ritchie coil; and thus the conditions of the last paragraph are fulfilled, provided the coil be sufficiently powerful.

Thirdly; Ritchie's Induction Apparatus (or, as the maker calls it, Ritchie's Rhumkorff's Induction Apparatus) is an apparatus in which, by very ingenious arrangements which this is not the proper place to describe, a very long and powerful spark is obtained from the secondary or induction current from a battery which may be of few cups and of small dimensions. The apparatus with which Mr. Wilson experimented before the Institute, is capable of giving a spark of 11 inches in length in the air. And as the resistance to the passage of the spark seems to be in the inverse ratio of the square of the distance; this power ought to be able to pass across more than seven thousand openings of $\frac{1}{8}$-inch each.

After thus briefly explaining the mode of lighting proposed by Mr- Wilson, and referring those particularly interested to the more full explanations given by Mr, W. in his remarks before the Institute at the meeting in March (see *Jour. Frank. Inst.*, vol. xxxix, p. 385), let us inquire into its novelty and its probable utility. Any student of electric science or practice will have at once suggested to his mind two modes in which this force may be used to ignite a current of gas at a distance: the first, by means of the heating power of the current while passing through an insufficient metallic conductor; under which circumstances the conductor becomes red, or even white hot; the other by means of the spark, which is in effect a small portion of matter intensely heated for a single moment. Now in order to meet the exigencies of practice, the mode of lighting, as Mr. Wilson very properly remarks, must be "simple, easy to adjust, efficient, reliable, and economical." Let us inquire how far these properties are possessed by each of the suggested modes.

And first as to the efficiency. The mode of lighting, by heating portions of a continuous conductor, depends upon the creation of a resistance to the passage of the current, by which resistance the heat is developed. In proportion, then, as you increase the number of your resistances you must increase the power of your battery—and as each retardation diminishes the amount of the current; if it happen that the second, or any succeeding wire is more capable of passing the current than the first, this wire will not heat. When, then, an attempt is made to ignite a number of gas-jets by fine platinum wires stretched above them, and communicating by means of a larger conductor, care must be taken that the first be not either finer or longer than any of the others, otherwise those which are coarser or shorter than the first will not produce their effect. Again, great care must be taken to insure an equality in the quantity of the current passed; for when the wires have been adjusted to a certain quantity, a less quantity will not heat them; a greater quantity will be liable to fuse them. Again, care must be taken that the wires are stretched immediately over the opening of the burners; a slight variation to the right or left will entirely prevent the lighting. When all these precautions are taken, a strong breeze of air, or even perhaps the current of gas issuing under a heavy pressure will cool the wires too rapidly to prevent the lighting. And it must be remembered that a low red heat is not sufficient to ignite a mixture of lighting-gas and air.

In reference to reliability; the wires are apt to fuse and thus break the connexion; to expand irregularly by the heat and thus be bent away from the opening of the burner; to incrust with soot, or dust, or damp, and thus prevent their ignition. They are simple but not easy to adjust or to keep in adjustment; and as to economy, require a much larger battery, and therefore more consumption of zinc and acid than the present plan.

But, in fact, from the operation of the causes we have pointed out under the heads of efficiency and reliability, this mode has always failed in practice, and we are obliged to have recourse to the spark, if we can succeed at all.

The great objection which has hitherto prevented the spark from being practically applicable to lighting gas, has been the difficulty of procuring and confining a current of sufficient intensity to overcome any great number of interruptions, and thus to produce the required number of sparks. The galvanic battery was not available, for the spark produced directly, is small and feeble; the electric machine is fragile, uncertain, difficult to keep in order, dependent on the weather, and laborious to work with. So that although propositions to light by spark are quite numerous both in England and France, yet in practice the method had never succeeded on trial, especially in a permanent manner.

Now the only practical method known to us of obtaining surely, efficiently, and easily, sparks sufficient for this purpose, is by the Induction coil, and we do not think we advance too far when we say by Ritchie's modification of this instrument; by which a spark of 11 or 15 inches can be produced, while heretofore they have never exceeded 3 inches.

The experiments made before the Committee and before the Institute by Mr. Wilson, as well as those which have been in operation for a year in New York on a practical scale, appear to demonstrate that this mode of lighting is efficient inasmuch as it is able to light many hundred burners at any distance within the limits of our largest rooms, and probably even in our streets; that it is reliable, inasmuch as it i not liable to get out of order, or to deteriorate (provided the wires fron which the sparks are taken are made of platina or some other refractin metal); that it is easy to adjust, requires no re-adjustment, unless by accident, when the damaged locality is easily detected and easily repaired; that it is simple, requiring no knowledge for its management, excep for the filling the cells of the battery (which need not exceed thre cups) with the acid, an operation probably not required more than onc a month if the apparatus is used several times every night; and it i economical, both because of the small quantities of material consume by the small battery required, and from the instantaneous action, savin a large quantity of gas which is now suffered to run to waste while th burners are lighted successively. The spark can also be repeated indefinitely and rapidly so as to light on a second or subsequent tria any burners which may have escaped the first attempt.

For these reasons, and on account of the experiments made in thei presence, as well as of those tried elsewhere, the Committee repor that in their opinion there is every reason to believe that Mr. Wilson' Electric Gas-lighter will be successful in practice; and that it is wel worthy of trial on a large scale.

By order of the Committee,

Wm. Hamilton, *Actuary.*

Philadelphia, June 14th, 1860.

BIBLIOGRAPHICAL NOTICE.

Elements of Chemical Physics. By Josiah P. Cook, Jr., Erving Professor of Chemistry and Mineralogy in Harvard University. Boston Little, Brown & Co., 1860, 8vo.

This work is intended especially to furnish to the student of chemistry a knowledge of such of the theories and facts in physics as ar likely to be of importance to him in the pursuit of his investigations and is designed to be the first volume of an extended work on th philosophy of chemistry. Of course, the work can hardly be fairl judged of until it is complete. The volume before us has the meri of being well brought up to the present state of knowledge upon th subject, but contains only the treatise on general properties of matte and that on heat, both of which are limited in accordance with th avowed purpose of the author. We fear, therefore, that if the worl be completed on the same scale, it will be of unwieldy bulk, and scarcel so well adapted to the purposes of the chemist as the more terse worl of Peschel, and others of his class. As a text-book of physics it ca hardly be made available in any course of instruction fitted to the demands of the present day owing to the want of all mathematical treatment of the subjects. The definitions, too, are not so precise as the ought to be in Science, and an apparent haste of writing has sometime led the author into errors of statement, which in a future edition shoul be carefully corrected: thus, for instance, on page 57, he affirms the centre of gravity of the earth to be a *variable* point *near* the centre of the globe. The work, however, is one of good promise, admirably printed and illustrated, (though it would have been better to have changed the French legends of the wood-cuts,) and the appendix contains a very valuable set of tables; one of which is a table of logarithms, which, if we understand the preface aright, has been calculated by Capt. Chas. Henry Davis.

F.

METEOROLOGY.

For the Journal of the Franklin Institute.

The Meteorology of Philadelphia. By James A. Kirkpatrick, A. M.

June.—The month commenced with indications of a coming storm. The barometric column began to fall on the 2d, and continued to fall until the afternoon of the 5th, when it reached the minimum for the month, reading at 2 P. M. of that day 29·243 inches. It then rose, slowly but regularly, until the 14th, when it again began to fall. This second wave reached its minimum on the 20th; after which it rose rapidly until the morning of the 25th, when it reached 30·123, the maximum for the month, and again gradually declined until the close. The newspapers soon brought the information of a very destructive tornado, commencing about Cedar Rapids in Iowa, on the evening of Sunday, the 3d of the month. It is described as dividing at Cedar Rapids into two winds, which passed very rapidly in curved lines to Camanche, where they united and crossed the river into Illinois, striking Albany and passing on to Amboy. The distance traversed was about 150 miles, which it accomplished in about two hours. Upwards of 200 lives were lost, and the destruction of property was very great.

On the evening of the same day a few drops of rain fell at Philadelphia; but on the next day, about 7 P. M., a heavy rain storm commenced, accompanied with thunder and lightning, and continued with but few intermissions until the morning of the 6th. During this period of two days and a half, about 2¼ inches of rain fell.

A heavy gale is also mentioned as having occurred in North Carolina on the morning of the 5th.

It is impossible with the limited information which we possess to determine whether or not these were all parts of the same storm.

On the morning of the 8th, a hail-storm continuing about fifteen minutes, passed over the northern part of the city; in the vicinity of Germantown and Manayunk a heavy rain fell at the same time, while in the southern part of the city there were but a few drops.

During the second depression of the barometer, from the 16th to the 19th of the month, we had several thunder-showers at Philadelphia; and we have accounts of a severe hail-storm and tornado in Lancaster County, Pa., on the 19th. Much damage was done to property by the wind, and the hail completely destroyed the crops along its route. The average width of the storm did not exceed three-quar ters of a mile.

The mean temperature of the month was about one degree highe than that of June of last year, but was nearly two degrees below th average of the month for the last nine years. The coldest day wa the 21st, the average temperature being 60°. The thermometer wa lowest on the morning of the 12th, when it indicated 52°. The the mometer was highest on the afternoon of the 29th, marking 93°; bu the 30th was the warmest day of the month, its average temperatur being 85·3.

Rain fell on ten days of the month, which is very near the averag number for June. The amount of rain which fell during the mont was 3·706 inches, which is an inch and a half less than that whic fell in June of last year, but not more than half an inch below th average for June for nine years.

There was but one day of the month entirely clear, and two day on which the sky was completely covered with clouds at the hours observation.

The force of vapor and relative humidity were both considerabl below the average for the month, as may be seen by an inspection the following table of comparisons.

A Comparison of some of the Meteorological Phenomena of June, 1860, *with tho of June,* 1859, *and of the same month for nine years, at Philadelphia.*

	June, 1860.	June, 1859.	June, 9 year
Thermometer.—Highest, . .	93°	96°	98°
" Lowest, . .	52	42	42
" Daily oscillation,	18·90	18·90	16·00
" Mean daily range,	4·20	6·10	4·60
" Means at 7 A. M.,	67·70	67·05	69·25
" " 2 P. M.,	78·38	76·76	79·29
" " 9 P. M.,	69·05	68·74	72·07
" " for the month,	71·71	70·85	73·54
Barometer.—Highest, . .	30·123 in.	30·152 in.	30·281 i
" Lowest, . . .	29·243	29·520	29·182
" Mean daily range, .	·088	·116	·096
" Means at 7 A. M., .	29·757	29·881	29·825
" " 2 P. M., .	29·719	29·842	29·791
" " 9 P. M., .	29·745	29·859	29 803
" " for the month,	29·740	29·861	29·806
Force of Vapor—Means at 7 A. M.	·467 in.	·501 in.	·527 i
" " " 2 P. M. .	·464	·541	·550
" " " 9 P. M.	·480	·512	·563
Relative Humidity at 7 A. M. .	68 per ct.	72 per ct.	73 per c
" " 2 P. M. ·	48	57	55
" " 9 P. M. .	67	72	70
Rain, amount in inches, . .	3·706	5·229	4·360
Number of days on which rain fell, .	10	12	11
Prevailing winds, . . .	N.67°23′w·236	s.71°2′ w. ·393	s.75°40′ w·25

Abstract of Meteorological Observations for May, 1860; made in Philadelphia, Franklin, Indiana, and Armstrong Counties, Pennsylvania, for the Committee on Meteorology of the Franklin Institute.

1860.	PHILADELPHIA.—Lat. 39° 57′ 28″ N. Long. 75° 10′ 28″ W. Height above the sea 50 feet. Prof. J. A. KIRKPATRICK, Observer.									CHAMBERSBURG, Franklin Co. Lat. 39° 58′ N. Long. 77° 45′ W. Height 618 ft. WM. HEYSER, Jr., Obs.							INDIANA, Indiana Co. 40° 40′ N. 79° 10′ W. Height, 1321 ft. W. B. HILDEBRAND, Obs.			FREEPORT, Armstrong Co. 40° 44′ N. 79° 42′ W. Height 1000 feet. J. H. BAIRD, Obs.		
	Barometer.		Thermometer.			Force of vapor.	Relative humidity.	Rain.	Pre-vail'g winds.	Barom	Thermom.		Force of vapor.	Relative humidity.	Rain.	Pre-vail'g winds.	Thermometer.		Pre-vail'g winds.	Thermometer.		Prevailing winds.
May.	Mean.	Mean daily range	Mean.	Daily oscillation.	Mean daily range.	2 P.M.	2 P. M.			Mean.	Mean.	Mean daily range.	2 P. M.	2 P. M.			Mean.	Mean daily range.		Mean.	Mean daily range.	
	Inch.	Inch.	°	°	°	Inch.	Per ct.	Inches.	Direc	Inch.	°	°	Inch.	Per ct	Inch.	Direc.	°	°	Direc.	°	°	Direc.
1	29·849	·076	47·7	6	6·8	·296	85	0·850	E N E.	29·346	49·0	3·7	·256	61	} 0·840	E.	45·7	21·0	(var.)	43·3	17·0	N W.
2	29·742	·107	53·0	12	5·3	·333	80	0·835	N E.	29·321	54·3	5·3	·296	52		E.	52·3	11·3	N.	53·0	9·7	(var.)
3	29·793	·052	55·3	11	3·7	·224	43	0·070	N N E.	29·346	60·7	6·3	·276	39		(var.)	62·3	16·0	N.	60·7	7·7	W.
4	29·773	·029	64·3	27	9·0	·325	39		NNW.	29 303	63·0	3·0	·345	42		(var.)	65·3	3·7	N W.	66·0	5·3	?
○ 5	29·796	·034	67·8	26	3·5	·328	34		(var.)	29·300	68·7	5·7	·382	37		E.	65·3	3·3	N W.	67·7	3·7	W.
6	29·791	·037	71 3	31	3·8	·433	38		S S W.	29·273	72·7	4·0	·411	36		E.	68·7	3·3	(var.)	70·7	4·3	S W.
7	29·728	·063	74·0	28	4 7	·548	40	0·475	(var.)	29·257	77·0	4·3	·850	68		(var.)	74·0	5·3	W.	74·7	4·0	S W.
8	29·859	·132	59·5	15	14·5	·445	77		N E.	29·320	73·0	4·7	·598	58		(var)	73 7	1·0	(var.)	71·7	3·7	?
9	29·845	·034	62·5	19	3·7	·465	61	0·042	N E.	29·250	64·0	9·0	·465	79	1·365	(var.)	70.7	3·3	N E.			(var.)
10	29·901	·056	61·7	6	4·5	·463	78	0·040	E S E.	29·205	67·3	5·3	·559	71	1·315	E.	63·0	7·7	E.	55·3		(var.)
11	29 973	·072	63·8	11	2·2	·470	71		S E.	29·246	63·3	4·0	·502	79	0 575	E.	64·0	3 7	E.	62·3	7·0	E.
☾ 12	30·018	·070	61·7	8	2·2	·516	91	0·240	S E.	29·286	62·7	0·7	.502	79	0·410	E.	63·3	4·0	S E.	59·0	4·7	E.
13	29·892	·126	67 2	22	6·5	·480	51	0·047	(var.)	29·219	62·0	1·0	·433	72	0·140	E.	63·7	5·7	S S E.			?
14	29·721	·170	64 8	13	4·0	·507	74	0·046	(var.)	29·097	66·3	4·0	·510	63		E.	63·7	3·3	S E.	65·0		N E.
15	29·864	·143	59·2	14	5·7	·282	44		(var.)	29·249	64·3	2·0	·350	46		N W.	68 7	5·0	E.	67·3	4·3	E.
16	29·837	·029	64·7	16	5·5	·270	28		S W.	29·214	67·3	3·0	·462	55		W.	67·7	1·0	N E.	63·7	3·7	N E.
17	29 992	·156	60.7	14	4·7	·376	55		E.	29·329	59·7	7·7	·356	62	0·085	(var.)	68·7	2·3	E.	67·0	4·3	N E.
18	29·847	·145	65·5	19	4·8	·517	63	0·044	(var.)	29·137	58·7	1·0	·491	88	0·417	E.	63·3	6·0	(var.)	62·3	5·7	S W.
19	29·522	·325	67·7	13	3 8	·332	40	0·017	S W.	28·824	62·7	4·0	·407	64	0·137	E.	59·0	5·7	(var.)	56·7	9·7	W.
● 20	29·679	·157	66 2	18	1·5	·353	45		W.	29·004	63·7	2·3	·206	28		(var.)	59·3	3·7	N W.	57·0	2·3	(var.)
21	29·770	·100	58·3	17	7·8	·353	50		N E.	29 041	60·3	3·3	·438	68	0·470	(var)	70·7	11·3	S W.	69·0	12·3	W.
22	29·764	·050	63·2	24	6·8	·520	66	0·155	W.	29·120	66·0	6·3	·532	63		N W.	66·7	4·7	(var.)	66·3	3·7	(var.)
23	29·873	·109	68·2	20	6·7	·383	45		N N E.	29 246	68·7	3·3	·442	55		(var.)	68·3	3·7	N W.	65·3	4·3	(var.)
24	29·933	·060	69.0	12	2·2	·369	38		WNW	29·245	68·3	2·3	·402	45		E.	72·7	5·0	E.	69·7	9·0	(var.)
25	29·871	·062	74·3	24	5·3	·566	52		S W.	29·206	70·7	6·7	·572	52		E.	75·0	2·3	S E.	74·0	4·3	?
26	29·691	·180	72·7	16	1·7	·594	58	0·063	S W.	29·045	68·0	7·0	·612	89	0·353	E.	72·0	3·0	W.	72·3	2 3	S W.
☽ 27	29·687	·073	59·8	16	9·8	·427	77	0·100	(var.)	29·008	68 3	5·0	·505	56	0 108	E.	64·0	11·3	S W.	58·7	13·7	?
28	29·718	·035	59·7	14	3·2	·534	84	0·005	N N E.	29·047	68·3	1 0	·420	68		W.	65·7	4·0	N W.	62·7	4·0	W.
29	29·887	·169	66·3	23	6·7	·344	40		N E.	29·215	70·7	2·7	·407	43		S E.	70·3	4·7	(var.)	69·0	6·3	(var.)
30	29 829	·085	64·3	18	4·0	·432	57	0·182	S E.	29·152	68·0	2·3	·608	80	0·128	S E.	71·0	4·0	S E.	71·7	6·0	(var.)
31	29·666	·163	72·3	20	8·0	·580	55	0·378	S.	29·021	70·0	3·0	·449	52		S E.	67.7	4·7	W.	64·7	7·0	W.
Means	29·810	·100	64·1	17	5·2	·421	57	3·589	N 59° E.	29·189	65·4	4·0	·459	60	6·343	S 87° E.	66·0	5·7	N 6° W.	64·4	6·3	N 60° W.

Abstract of Meteorological Observations for May, 1860; made in Adams, Dauphin, Northumberland, Centre, and Somerset Counties, Pennsylvania, for the Committee on Meteorology of the Franklin Institute.

1860.	Gettysburg, Adams Co. Lat. 39° 49′ N. Long. 77° 18′ W. Height 624 ft. Prof. M. Jacobs, Obs.				Harrisburg, Dauphin Co. 40°16′, N. 76°50′, W. Ht., 300 ft. John Heisely, M.D., Obs.					Shamokin, Northumberland. Co. 40° 45′ N. 76° 30′ W. Height, 700 ft. P. Friel, Obs				Fleming, Centre Co. 40° 55′ N. 77° 53′ W. Height, 780 feet. S. Brugger, Obs.				Somerset, Somerset Co. Lat. 40° N. Long. 79° 3′ W. Height 2195 feet. Geo. Mowry, Observer.						
May.	Thermometer.		Rain.	Pre-vail'g winds.	Barom	Thermom.		Rain.	Pre-vail'g winds.	Thermom.		Rain.	Pre-vail'g winds.	Thermom.		Rain.	Prevail-ing winds.	Barom	Thermom.		Force of vapor.	Rela-tive humi-dity.	Rain.	Pre-vail'g winds.
	Mean.	Mean daily range.			Mean.	Mean.	Mean daily range.			Mean.	Mean daily range.			Mean.	Mean daily range.			Mean.	Mean.	Mean daily range.	2 P.M.	2 P.M.		
	°	°	Inch.	Direc.	Inch.	°	°	Inch.	Direc.	°	°	Inch.	Direc	°	°	Inch.	Direc.	Inch.	°	°	Inch.	Per ct.	Inch.	Direc.
1	43·3	10·3	1·087	N E.	29·755	49·7	5·3	1·217	E.	47·0	1·0	1·250	S E.	51·7	2·7	0·435	(var.)	27·642	42·7	8·0	·214	69	0·472	W.
2	49·7	5·3		N E.	29·696	55·0	5·3		N E.	55·3	10·3		E.	54·7	4·3		W.	27·679	45·3	5·3	·323	92	0 108	W.
3	52·0	3·3		N E.					(var.)	59·0	3·0		W.	56·7	6·0		(var.)	27·695	53·0	7 7	·289	42		N.
4	61·7	8·7		E.	29 687	64·7			(var.)	59·0	6·7		W.	61·3	6·0		W.	27·662	61·7	8·7	·475	58		W.
○ 5	72·3	11·7		W.	29·674	69·0	4·3		N.	60·0	1·7		W.	65·0	5·7		W.	27·633	63 0	8·0	·374	36		W.
6	71·0	2·7		?	29·664	72·7	3 7		W.	64·7	8·7		W.	66·7	3·0		(var.)	27·626	70·0	7·0	·542	42		W.
7	74·0	3·0		S E.	29·601	76·0	6·0	0·216	(var.)	70·0	5·3	1·014	(var.)	72·7	6·0	0 710	(var.)	27·625	70·7	5·0	·584	55	0·145	W.
8	72·7	3 3		(var.)	29·720	68·3	7·0		E.	65·3	7·3	0·050	E.	71·0	5·0		S E.	27·624	72 3	2·3	·555	45	0·191	S.
9	63·3	9·3	2·270	E.	29·680	63·0	6·0	1.194	E.	62·3	3·0		E.	62·7	8·3	0·620	S E.	27·540	61·3	11·0	·447	77	1·089	S E.
10	62·7	3·7		S E.	29·698	64·7	3·0		E.	59·3	5·7	0·843	S E.	63·0	3·0	2·430	S E.	27·567	56·0	5·3	·380	76	0·738	(var.)
11	61·8	3·2	0·700	S E.	29·815	64·7	0·0		E.	59·3	3·3	2·372	E.	62·7	3·0	0·610	S E.	27·657	58·3	2·3	·406	74	0·132	S E.
☾ 12	61·0	1·2	0·600	S E.	29·854	63·3	1·3	0 531	E.	61·7	1·0	0·050	E.	64·0	2·7	0·185	E.	27·696	55·7	2·7	·391	87	0·890	S E.
13	63·3	6·3	0·204	(var.)	29·752	65·3	2·0	0·309	E.	61·3	2·3	0·412	E.	62·3	1·7	0·050	W.	27·657	62·7	7·0	·497	59	0·036	W.
14	71·7	7·7		S E.	29·601	66·0	2·7	0·400	W.	62·7	6·7	0·100	W.	64·0	5·0	0·230	N E.	27·604	61·3	4·0	·429	56		W.
15	61·7	9·3		(var.)	29·731	64·0	2·0		E.	60·0	2·7		W.	60·3	3·7		(var.)	27·623	64·3	5·0	·549	57		S.
16	65·3	5·7		?	29·708	68·3	4·3		W.	63·7	6·3		W.	66 0	5·7		W.	27·647	63·0	2·7	·381	44		N.
17	58·7	6·7		S E.	29·881	59·3	9·0		N E.	55·7	11·3		E.	61·0	5·7		E.	27·715	64·7	2·3	·484	52	1·136	(var.)
18	60·5	2·2	0·163	S.	29·693	62·0	2·7	0·257	N E.	61·7	6·0	0·321	E.	59·3	1·7	0·200	(var.)	27·535	59·0	5·7	475	69	0·202	(var.)
19	59·3	1·8		S W.	29·331	64·7	4·0		S W.	58·0	4·7	0·128	W.	58·0	2·7	0·470	N W.	27·364	55·3	3·7	·316	62	0·076	W.
● 20	65·3	6·0		N W.	29·530	66·0	1·3		W.	56·0	3.3		W.	57·3	4·7		N W.	27 577	56·0	3·3	·311	56		W.
21	62·0	6 7		E.	29·596	58·7	7·3	0·208	N E.	50·0	6·0	2·461	E.	58·0	3 3	1·165	(var.)	27 530	68 0	12·0	·664	69	0·182	(var.)
22	67·2	5·2	0·220	S E.	29·655	63·7	5·7	0·082	W.	55·7	5·7	0·371	E.	65·3	8·0	0·090	N W.	27·665	66·7	3·3	·573	58		WSW.
23	66·7	2·5		(var.)	29 782	69·3	5·7		N.	60·3	4·0		W.	66·3	2·3		(var.)	27·771	63·3	3·3	·448	52		W.
24	70·0	5·3		?	29·804	69·3	3·3		N.	61·7	2·7		W.	68·0	3·0		(var.)	27·770	66·3	3·0	·491	53		(var.)
25	72·7	5·3		S.	29·717	74·0	4·7		S W.	65 7	4·0		W.	71·0	4·3		S E.	27·683	69·7	3·3	·616	58	0·811	S E.
26	69·3	3·3	0·370	S W.	29·553	73·0	5·7	0·072	(var.)	67·0	12·7	0·550	S W.	73·0	4·7	0·040	S W.	27·576	69·7	2 0	·650	66	0·060	(var.)
☽ 27	68·3	2·3		N W.	29·513	70·3	2 7		S W.	64·7	3·7	0·010	W.	62·0	11·0		(var.)	27·565	60·0	9·7	·451	73	0·116	W.
28	64·7	4·3	0·030	?	29·598	69·3	3·7		N.	60·7	4·0		W.	62·3	2·3		N W.	27·600	59·0	5·0	·403	53		W.
29	69·5	4·8		(var.)	29·760	70·7	2·0		(var.)	65·7	10·3		E.	69·7	7·3		S E.	27·703	64·0	5·0	·442	50		S E.
30	66·3	5·5	0·004	S.	29·663	70.3	3·7	0·307	(var.)	68·0	9·7	0·375	(var.)	66·0	3·7	0·140	S E.	27·615	63·0	8·3	·436	80	0·409	S.
31	70·7	5·7		W.	29·488	73·7	3·3		S W.	67·7	5·7	0·138	W.	65·7	3 0	0·050	W.	27·544	63·0	6·7	·455	58	0·141	W.
Means	64·9	5·2	5·648	s 47° e.	29·673	66·3	4·1	4·793	n56°e.	60·9	5·4	10·445	s14°e.	63·5	4·5	7·425	s50°w.	27·625	61·6	5·4	·453	60	6·734	s34°w.

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FOR THE

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CIVIL ENGINEERING.

Angular Troughs or Pipes, and Angular Bottoms to Drains.[*] By C. H. G. Thost.

Dissatisfied with the means of conveying the lead-ore from the mines to the stamping mills at Tyndrum Mines, I was led to devote my attention to the possibility of taking advantage of the moving power of water in close drains or pipes.

For this purpose a square pipe or trough was laid down from the entrance of the mine to the low grounds, a distance of 1200 feet, and having an inclination varying from 13 to 20 degrees. But though the water rushed through this pipe with great velocity, it failed to carry the fragments of ore along with it; these choked up the very mouth of the pipe. Having, therefore, failed in carrying out the idea in the square tube, numerous experiments were tried as to whether altering the form of the pipe would enable the object to be effected. The results showed such a superiority of the angular over the flat, curved, or other forms of bottom, that it was determined to try the experiment once more on the large scale with a tube of that form. The square box or pipe which had been laid down from the entrance of the mine to the low grounds was, therefore, as a preliminary turned on its edge, so that its bottom, instead of being flat, represented an angular channel, each side of which was inclined at an angle of 45°.

The lead ore, broken to the size of ordinary road metal, was fed by a hopper into the top of the tube; a moderate stream of water was admitted along with it, and the whole ore was passed through the tube with an astonishing rapidity, and was delivered at the bottom, no choking taking place at all. Further experiments were made to ascertain the best angle at which the two sides of the base should meet, and it was found that a right angle answered all the purposes better than any other. With such an angle a smaller quantity of water was required to move the pieces of ore in the tubes; and the smallest gravel also, or even the powder of the ore, could be most effectually sent down.

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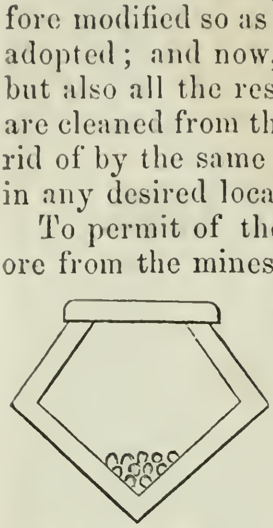
[*] From the London Civ. Eng. and Arch. Jour., March, 1860.

The whole arrangements and general working of the mine were therefore modified so as to permit of this new mode of moving the ore being adopted; and now, not only is the whole ore conveyed by this means, but also all the residuary masses of quartz and other minerals which are cleaned from the lead ores previous to their transmission, are all got rid of by the same means, and deposited with little labor or expense in any desired locality.



To permit of the great wooden trough or pipe which conveys the ore from the mines to the low grounds being easily inspected and repaired, it is now made of the figure represented by the accompanying wood-cut, being in fact just the square box set on one of its angles, and having the upper angle sawn off. A movable cover is fixed securely down by means of cross bands of hoop iron, the ends of these bands being secured by means of iron pins, so that any part of the trough can be readily opened for repairs. The lower angle of the pipe is lined with hoop iron, as without this protection it was found that the angular fragments rapidly wore away the wooden sides. When thus protected, the friction against the sides seems to be much less than might have been anticipated.

Let us now consider the conditions under which the action of the water in moving these masses of ore down such a tube takes place. The resisting power or stability of a block of ore is diminished by the inclination of the tube and by the buoying-up power of the water; and the effectiveness of the action of the stream against the block is secured by the latter not being able to assume any firm position in the channel where it could escape that action. The inclined direction of the flat parts of the tube can offer no such hold to the block as it could obtain in the case of a flat bottomed channel. In the experiments with the flat bottomed tube, when the fragment fell on its flat side, there it stuck; but in the angular tube, from only touching the sides by one or more corners, it was in a position to be easily acted upon by the current.

The cost of this mode of conveyance may now be stated. The original cost of the angular wooden trough at Tyndrum, 1200 feet long, including all fittings, and lining the lower angle with hoop iron, was £70. This trough has been many years in use, and is still quite good; but the annual repairs, chiefly consisting of the renewal of the hoop iron lining, amount to £11 or thereabout. This trough conveys yearly to the low grounds from 1100 to 1200 tons of ore. The ore is supplied to the pipe through the mouth of a hopper; the person attending to this is able, for the wages of one shilling, to get 40 tons down. This mode of conveyance is therefore the very cheapest yet tried, and as the same means are now applied to the removal of all the debris from the mines, the saving of expense is very considerable. The like system is now employed in the various processes of dressing and washing the ores, the troughs in these cases being open, and many of them are nearly level.

I wish to direct attention to the application of the angular form of bottom to ordinary drains and sewers. It is well known that the great object in giving a particular form to drains or sewers is to prevent the deposit and lodging of mud or sediment of any kind in them. Flat bottomed drains were found to silt up so soon that they have been generally abandoned; and as it was seen that circular pipes did not so easily become obstructed, some approach to the round form has been usually given, thereby incurring considerable expense. Now though sediment of any kind is much less liable to collect in these curved bottom drains, yet they are inferior in this respect to the drain with an angular bottom, as has been fully brought out during the numerous trials I had to make at Tyndrum before hitting on the angular form. And as I there found that even the finest powder of lead ore (which is many times heavier than ordinary mud or sand) was removed from these angular pipes even when at the most moderate inclinations, I am inclined to believe that the general adoption of the angular bottom for all kinds of drains would be a great improvement. In this form of bottom, however small the flow of water may be, it always runs at that part where the sediment can alone settle; and on the occurrence of any greater flow of water, either from heavy rains or occasional flushings, every particle of solid matter would be carried out of the drain.

The adoption, then, of the angular bottom would not only appear to form a more perfect sewer than those at present in use, but from the cheaper character of the bottom a considerable saving in the original outlay would thereby be effected. The bottom angle might be constructed with brick in good cement, or be lined with hard flat stones; but the important point to be attended to is to make the junction at the angle perfectly secure.

On the Illumination of Light-houses—The Electric Light.[*] By M. Faraday, D. C. L., F. R. S., Fullerian Professor of Chemistry, R.I., Foreign Associate of the Academy of Sciences, Paris, &c.

There is no part of my life which more than my connexion with the Trinity House gives me delight. The occupation of nations joined together to guide the mariner over the sea, to all a point of great interest, is infinitely more so to those who are concerned in the operations which they carry into effect, and it certainly has astonished me since I have been connected with the Trinity House to see how beautifully and how wonderfully shines forth amongst nations at large the desire to do good; and you will not regret having come here to-night, if you follow me

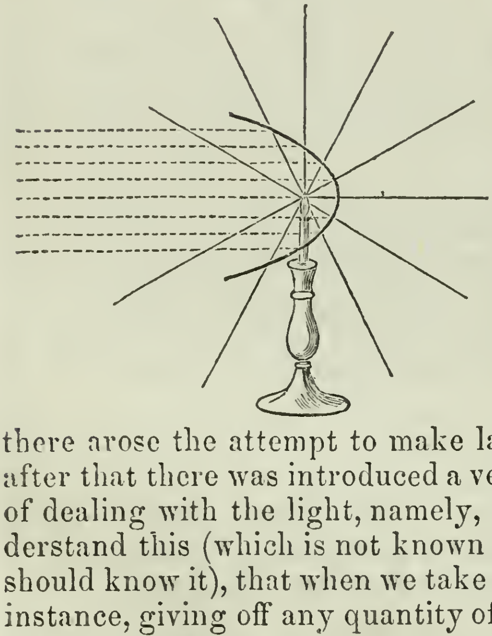
[*] From the London Chemical News, No. 15.

in the various attempts which have been made to carry out the great object of guiding in safety all people across the dark and dreary waste of waters. It is wonderful to think how eagerly efforts at improvement are made by the various public bodies—the Trinity House in this country, and commissions in France and other nations; and whilst the improvements progress we come to the knowledge of such curious difficulties and such odd modes of getting over those difficulties as are not easy to be conceived. I must ask you this evening to follow me from the simplest possible method of giving a sign by means of a light to persons at a distance, to the modes at which we have arrived in the present day; and to consider the difficulties which arise when carrying out these improvements to a practical result, and the extraordinary care which those who have to judge on these points must take in order to guard against the too hasty adoption of some fancied improvement, thus, as has happened in some few cases, doing harm instead of good.

If I try to make you understand these things partly by old models, and partly by those which we have here, it is only that I may the better be enabled to illustrate that which I look forward to as the higher mode of lighting, by means of the electric lamp and the lime light.

There is nothing more simple than a candle being set down in a cottage window to guide a husband to his home, but when we want to make a similar guide on a large scale, not merely over a river or over a moor, but over large expanses of sea, how can we then make the signal using only a candle? I have shown in this diagram (Fig. 1) what we may imagine to be the rays of a candle or any other source of light emanating from the centre of a sphere in all directions round to infinite distances. After this simple kind of light had been used for some time, it being found to be liable to be obscured by fogs, or distance, or other circumstance, there arose the attempt to make larger lights by means of fires; and after that there was introduced a very important refinement in the mode of dealing with the light, namely, the principle of reflection;—for understand this (which is not known by all, and not known by many who should know it), that when we take a source of light, a single candle, for instance, giving off any quantity of light, we can by no means increase that light; we can make arrangements around and about the light, as you see here, but we can by no means *increase the quantity* of light. The utmost I can do is to *direct* the light which the lamp gives me by taking a certain portion of the rays going off on one side and reflecting them on to the course of the rays which issue in the opposite direction. First of all, let us consider how we may gather in the rays of light which pass off from this candle. You will easily see that if I could take the half rays on the one side and could send them by any con-

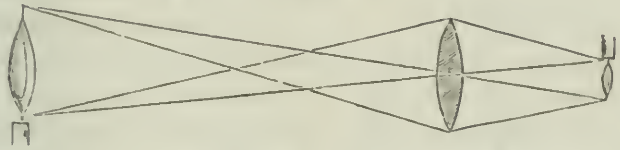
Fig. 1.



trivance over to the other side, I should gain an advantage in light on the side to which I directed them. This is effected in a beautiful manner by the parabolic mirror, by means of which I gather all that portion of the rays which are included in it; upwards, downwards, sideways, any where within its sphere of action; they are all picked up and sent forward. You thus see what a beautiful and important invention is that of the parabolic reflector for throwing forward the rays of light.

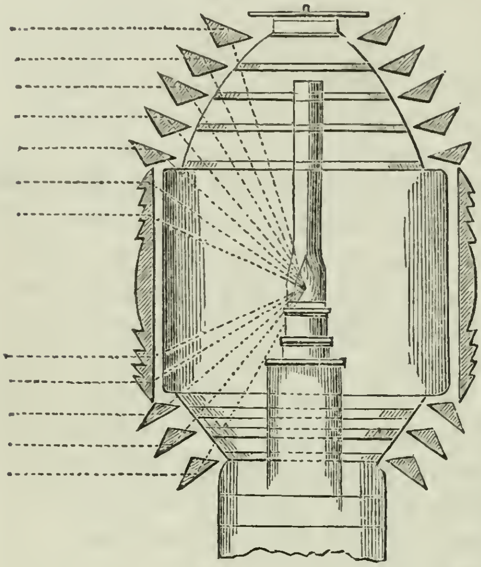
Before I go further into the subject of reflection let me point out a further mode of dealing with the direction of the light. For instance, here is a candle, and I can employ the principle of *refraction* to bend and direct the rays of light, and if I want to increase the light in any one direction I must either take a reflector or use the principle of refraction. I will place this lens (Fig. 2) in front of the candle and you will easily see that by its means I can throw on to that sheet of paper a great light, that is to say, that instead of the light being thrown all about, it is *refracted* and concentrated on to that paper; so here I have another means of bending the light and sending it in one direction; and you see above a still better arrangement for the same purpose,—one which comes up to the maximum, I may say, of the ability of directing light by this means. You are aware that without that arrangement of glass the light would be dispersed in all directions, but the lens being there, all the light which passes through it is thrown into parallel beams and cast horizontally along. There is consequently no loss of light, the beam goes forward of the same dimensions, and will consequently continue to go forward for 5 or 10 miles, or so long as the imperfection of the atmosphere does not absorb it; and see! What a glorious power that is, to be able to convert what was just now darkness on that paper into brilliant light.

Fig. 2.



Whenever we have refraction of this sort we are liable to an evil consequent upon the necessary imperfections in the form of the lens; and Dr. Tyndall will take this lens, and will show you even in this small and perfect apparatus what is the evil of spherical aberration with which we have to fight. This can be illustrated by means of the electric lamp; if you look at the screen, you will see produced, by means of this lens, a figure of the coal points. This image is produced by the rays which pass through the *middle* of the lens, a piece of card with a hole in the centre being placed in front; but if, keeping the rest of the apparatus in the same position, I change this card for another piece which will only allow the rays to pass through the *edge* of the lens, you observe how inferior the image will be. In order to get it distinct I have to bring the screen much nearer the lamp; and so if I take the card away altogether, and allow the light to pass through all parts of the lens, we cannot get a perfect image, because the different parts of the lens are not able to act together. This spherical aberration is, therefore, what we try to avoid by building up compound lenses in the manner here shown (Fig. 4). Look at this beautiful apparatus, is it not a most charming piece of workmanship? Buffon first and Fresnel afterwards, built up these kinds of lenses, ring within ring, each at its proper adjustment, to compensate for the effects of spherical aberration; the ring round that centre lens is ground so as to obviate what would otherwise give rise to spherical aberration, and the next ring being corrected in the same manner, you will perceive, if you look at the disc of light thrown by the apparatus up-stairs, that there is nothing like the amount of aberration that there would have been if it had been one great bulls-eye. Here is one of Fresnel's lamps of the fourth order so constructed (Fig. 3): observe the fine effect obtained by these different lenses as you see them revolve before you, and understand that all this upper part is made to form part of the lens, each prism throwing its rays to increase the effect, and, although you may think it is imperfect because if you happen to sit below or above the horizontal line, you perceive but little if any of the light, yet you must bear in mind that we want the rays to go in a straight line to the horizon. So that all that building up of rings of glass is for the purpose of producing one fine and glorious lens of a large size, to send the rays all in one direction. Here is another apparatus used to pull the rays down to a horizontal sheet of light, so that the mariner may see it as a constant and uniform fixed light; the former lamp is a revolving one, and the light is seen only at certain times as the lenses move round, and these are the points which make them valuable in their application.

Fig. 3.



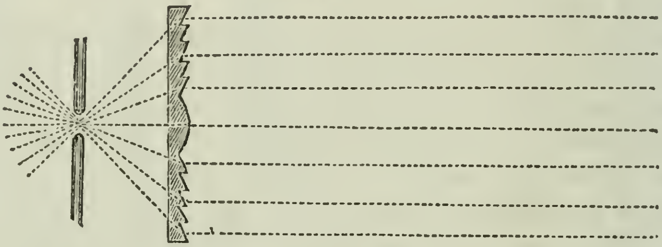
There are various orders and sizes of lights in light-houses to shine for twenty or thirty miles over the sea, and to give indications according to the purposes for which they are required; but suppose we want more effect than is produced by these means, how are we to get more light? Here comes the difficulty. We cannot get more light, because we are limited by the condition of the burner. In any of these cases, if the spreading of the ray, or *divergence* as it is called, is not restrained, it soon fails from weakness, and if it does not diverge at all, it makes the light so small that perhaps one in a hundred can see it at the same time. The North Foreland light-house is, I think, 3 or 400 feet above the level of the sea, and therefore it is necessary to have a certain divergence of the beam of light in order that it may shine along the sea to the horizon. I have drawn here two wedges, one has an angle of 15°, and shows you the manner in which the light opens out from this reflector seen at the distance of half a mile or more, the other wedge has an angle of 6°, which is the beautiful angle of Fresnel. When the angle is less than 6°, the mariner is not quite sure that he will see the light—he may be beneath or above it; and in practice it is found that we cannot have a larger angle than 15°, or a less one than 6°. In order, therefore, to get more light, we must have more combustion, more cotton, more oil; but already there are in that lamp four wicks put in concentric rings, one within the other, and we cannot increase them much more, owing to the divergence which would be caused by an increase in the size of the light—the more the divergence, the more the light is diffused and lost. We are, therefore, restrained by the condition of the light and the apparatus to a certain sized lamp. At Teignmouth, some of the revolving lights have ten lamps and reflectors, all throwing their light forward at once. But even with ten lamps and reflectors we do not get sufficient light, and we want, therefore, a means of getting a light more intense than a candle in the space of a candle—not merely an accumulation of candle upon candle, but a concentration into the space of a candle, of a greater amount of light, and it is here that the electric light comes to be of so much value.

Let me now show you what are the properties of that light which make it useful for light-house illumination, and which has been brought to a practical condition by the energy and constancy of Prof. Holmes. I will first of all show you the image of the charcoal points on the screen, and draw your attention to the spot where the light is produced. There are the coal points. The two carbons are brought within a certain distance; the electricity is being urged across by the voltaic battery, and the coal points are brought into an intense state of ignition. You will observe that the light is essentially given by the carbons; you see that one is much more luminous than the other, and that is the end which principally form the spark, the other does not shine so much, and there is a space between the two, which, although not very luminous, is most important to the production of the light. Dr. Tyndall will help me in showing you that a blast of wind will blow out that light; the electric light can, in fact, be blown out easier than a candle. We have the power of getting our light where we please; if I cause the electricity to pass between carbon and mercury I get a most intense and beautiful light, most of it being given off from the portion of the mercury between the liquid and the solid pole. I can show you that the light is sometimes produced by the vapor between the two poles, better if I take silver than when I use mercury. Here is the carbon pole, there is the silver, and there is the beautiful green light which comes from the intervening portions. Now that light is more easily blown out than the common lamp, the slightest puff of wind being sufficient to extinguish it, as you will see if Dr. Tyndall breathes upon it.

You see, therefore, how we are able, by using this electric spark, to get, first of all, the light into a very small space. That oil lamp has a burner 3¾ inches in diameter; compare the size of the flame with the space occupied by this electric light. Next compare the intensity of this light with any other; if I take this candle and place it by the side, I actually seem to put out the candle. We are thus able to get a light which, while it surpasses all others in brilliancy, is at the same time not too large, for I might put this light into an apparatus not larger than a hat, and yet I could count upon the rays being useful. Moreover, when such large burners are used in a lantern, we have to consider whether the bars of the window do not interfere to throw a shadow or otherwise; but with this light there will be no difficulty of that sort, as a single small speculum no larger than a hat will send it in any direction we please; and it is wonderful what advantages, by reason of its small bulk, we have in the consideration of the different kinds of apparatus required, reflecting or refracting, irrespective of other reasons for using the electric light. And it is these kind of things which make us decide most earnestly and carefully in favor of the electric light.

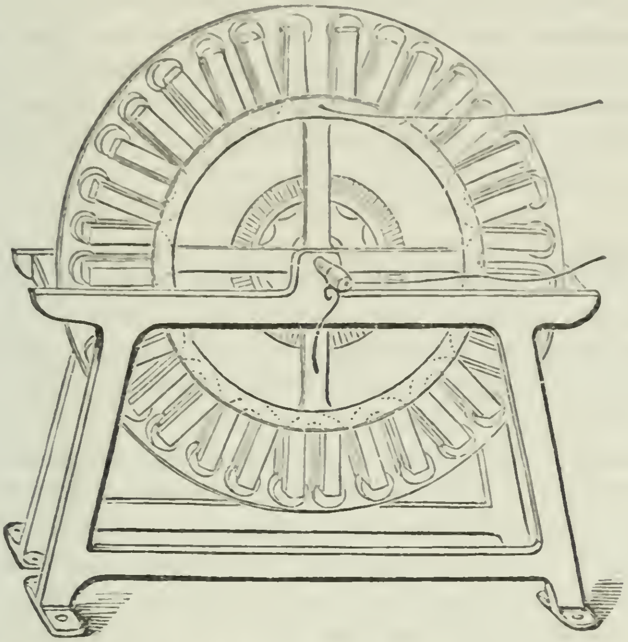
I am going to show you the effect that will take place with that large lens when we throw the oil lamp out of action, and put the electric light into use. It is astonishing to find how little the eye can compare the relative intensities of two lights; look at that screen and try to recollect the amount of light thrown upon it from the 3¾ inch lamp of Fresnel, and now, when we shift the lens sideways, look at the glorious light arising from that small carbon point (Fig. 4); see how beautifully it shines in the focus of that lens and throws the rays forward. At present the electric light is put at just the same distance as the oil light, and therefore, being in the focus of the lens, we have parallel rays which are thrown forward in a perfectly straight line, as you will see by comparing the size of the lens with that of the light thrown on the screen. You will now see how far we can effect this beam of light by increasing or diminishing the distance of the lamp. We are able by a small adjustment to get a beam of a large or small angle, and observe what power I have now over it; for if I want to increase the degrees of divergence, I am limited by the power of light in the case of the oil lamp, but with the electric light I can make it spread over any width of the horizon by this simple adjustment. These then are some of the reasons which make it desirable to employ the electric light.

Fig. 4.



By means of a magnet, and of motion, we can get the same kind of electricity as I have here from the battery; and under the authority f the Trinity House, Professor Holmes has been occupied in intro-lucing the magneto-electric light in the light-house at the North Fore-and; for the voltaic battery has been tried under every conceivable ircumstance, and I take the liberty of saying it has hitherto proved decided failure. Here, however, is an instrument wrought only by nechanical motion. The moment we give motion to this soft iron in ront of the magnet, we get a spark. It is true in this apparatus it is ery small, but it is sufficient for you to judge of its character. It is he *magneto-electric* light, and an instrument has been constructed as ere shown (Fig. 5), which represents a number of magnets placed ra-lially upon a wheel—three wheels of magnets and two sets of helices.

Fig. 5.



Vhen the machine, which is worked by a two horse power engine, is roperly set in motion, and the different currents are all brought to-ether, and thrown by Professor Holmes up into the lantern, we have light equal to the one we have been using this evening. For the st six months the North Foreland has been shining by means of this lectric light—beyond all comparison better than its former light. It as shone into France, and has been seen there and taken notice of by he authorities, who work with beautiful accord with us in all these atters. Never for once during six months has it failed in doing its uty;—never once, more than was expected by the inventor. It has hone forth with its own peculiar character, and this even with the ld apparatus—for as yet no attempt has been made to construct spe-ial reflectors or refractors for it, because it is not yet established. I ill not tell you that the problem of employing the magneto-electric park for light-house illumination is quite solved yet, although I desire t should be established most earnestly (for I regard this magnetic park as one of my own offspring). The thing is not yet decidedly ac-omplished, and what the considerations of expense and other matters may be, I cannot tell. I am only here to tell you as a philosopher, how far the results have been carried, but I do hope that the authorities will find it a proper thing to carry out in full. If it cannot be introduced at all the light-houses, if it can only be used at one, why really it will be an honor to the nation which can originate such an improvement as this,—one which must of necessity be followed by other nations.

You may ask, what is the use of this bright light? It would not be useful to us were it not for the constant changes which are taking place in the atmosphere, which is never pure. Even when we can see the stars clearly on a bright night it is not a pure atmosphere. The light of a light-house, more than any other, is liable to be dimmed by vapors and fogs, and where we most want this great power, is not in the finest condition of the atmosphere, but when the mariner is in danger, when the sleet and rain are falling, and the fogs arise, and the winds are blowing, and he is nearing coasts where the water is shallow and abounds with rocks—then is his time of danger, when he most wants this light. I am going to show you how, by means of a little steam, I can completely obscure this glorious sun, this electric light which you see. The cloud now obscuring the light on the screen is only such a cloud as you see when sitting in a train on a fine summer's day; you may observe that the vapor, passing out of the funnel, casts as deep a shadow on the ground as the black funnel; the very sun itself is extinguished by the steam from the funnel, so that it cannot give any light; and the sun itself if set in the light-house would not be able to penetrate such a vapor.

Now the haze of this cloud of steam is just what we have to overcome, and the electric light is as soon, proportionally, extinguished by an obstruction of this kind as any other light. If we take two lights, one four times the intensity of the other, and we extinguish half of one by a vapor, we extinguish half of the other, and that is a fact which cannot be set aside by any arrangement. But then we fall back upon the *amount* of light which the electric spark does give us in aid of the power of penetrating the fog, for the light of the electric spark shines so far at times, that even before it has arisen above the horizon twenty-five miles off, it can be seen. This intense light has, therefore, that power which we can take advantage of,—of bearing a great deal of obstruction before it is entirely obscured by fogs or otherwise.

Taking care that we do not lead our authorities into error by the advice given, we hope that we shall soon be able to recommend the Trinity House, from what has passed, to establish either one or more good electric lights in this country.

Increase of the Bite of Locomotives on Railways.[*]

In another part of our impression we give an account of an invention, with some experiments, of Mr. E. W. Serrell, an American civil engineer, from the *Journal of the Franklin Institute*, for increasing the bite of the engine wheels on the rails by means of electro-magnetsm. Though we admit the importance of the invention, if generally racticable, we cannot see that it will allow of so much reduction in he weight of the locomotive, though it would of some, as the inventor eems to think. The power of the engine resides in its boiler, every art of which, with the working gear and driving wheels, must have trength with proportional weight to bear the full, and more than the ull, strain of the steam in the boiler, and to resist the shocks occaioned by the velocity on the road. There is, however, one great beneit the invention would confer both upon the traveling public and the ailway Companies. It would go far to lessen the number of accidents y the engine leaving the rails. For if the mutual adhesion between he wheels and rails be increased, the chances of the engine jumping ff the rails will be diminished, and that would be more particulary so f the driving wheels, as we have heretofore recommended, were placed n the fore part of the engine. Coupled engines, too, which on curved ines produce great strains and consequent wear and tear, would be ess needful if Mr. Serrell's invention could be brought into use.

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[*] From Herapath's Railway Journal, No. 1071.

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*On the Decay and Preservation of Building Materials.** By Prof. D. T. Ansted, M. A., F. R. S.

[The following Lecture was delivered at the Royal Institution on the 24th May, 1860.]

The subject of my present lecture is eminently practical, and hardly dmits of much variety of illustration ; but I am sure that none of you an have examined, or even glanced at the numerous specimens of rchitectural construction in the older and more picturesque cities of ngland and the Continent—you cannot have admired the graceful traery of Westminster Abbey,—you cannot even have looked at the rich etail of the noble building recently erected so near it, by one whose enius will, perhaps, be willingly acknowledged, now that he has eparted from amongst us, without noticing the facts I am about to efer to.

You will there see, at every turn, fresh proof of apparently capriious and unaccountable decay. You will find many old stones unalered, while many new ones are fast mouldering into rottenness ; and ou will, I believe, be interested, in spite of the apparent dryness of he subject, in anything that will inform you about a result so painful, o irregular, and so desirable to check, if in any way prevention is ossible.

Our building materials are of several kinds. Let me point out to ou the principal varieties—their peculiar uses—their relative value or special purposes—and the special causes of decay in each. I shall hen endeavor to put before you the modes by which such materials ay be, at least in some measure, preserved from decay.

There is one thing which I may say with regard to all building maerials of the nature of stone,—namely, that wherever it is found formng part of the earth's crust as a mass of rock, it is invariably,—if it omes to the surface at all—injured and altered near the surface. In a granite district, for example, where there is scarcely any soil lying over the granite, it scarcely ever happens that the upper portion of the granite does not, to a certain extent, exhibit marks of alteration. In all the common absorbent stones which are ordinarily used for building purposes, this is much more remarkably the case. And, to a certain extent, the rate at which the stone would be injured may be estimated by its appearance where it has been thus exposed for a long time to the action of the atmosphere. But that can only be taken as a partial measure of the injury likely to occur, because in some cases it will happen that the stone will stand exposure perfectly well in its own atmosphere, and when the surface only is exposed, without having been removed from the bed, although that same stone, when it is removed from the bed, particularly when it is placed in a different position from that which it occupied in the bed, will decay much more rapidly. Still, as I have said, it is an indication, and you will generally find that in a granite district a surface of good granite is exceedingly hard close to the top, and a decomposing granite worn and rotten. In a sandstone district there will also be a certain amount of decomposition dependent on the value of the stone. And in a limestone district there will generally be considerable decomposition; in fact the whole of the upper bed of limestone will be converted into vegetable soil.

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* From the Journal of the Society of Arts, No. 396.

Let us now take the building materials in regular order. First of all there is the group of which granite is the representative. A very remarkable group of stones is this, which are perfectly familiar to every one. With respect to it, therefore, I shall not waste your time in definitions, and merely remark that as it is one of the hardest, and, in some respects, one of the most valuable stones we have, yet in many respects, although very useful, it is almost impracticable for delicate ornamentation. Granite 'consists of a number of crystals embedded in a crystalline base. In other words, it is a mass of crystalline minerals crystallized altogether. That is the essential nature of granite, and the point in which it differs from most other stones. This explains at once its value, and the nature of its decay. Its value, because granite, being composed entirely of crystallized matter, is non-absorbent, and very little exposed to injury, so that there is no opportunity for decomposing agencies to get to it, without the lapse of a very long period of time. But it is also necessary to observe that granite consists of various kinds of crystals, and these not being always composed in the same manner, some are more liable to decay than others. Among the crystals that form granite are crystals of quartz, a material so durable that one hardly expects it to fail at all. But quartz, under certain circumstances, is capable of assuming a state in which, by the action of the weather, it will decay. This very peculiar state I shall speak of afterwards, when I have to ask your attention to some means of preventing decay. It is a fact—and I allude to it now as one of the ways in which granite appears subject to decay. A portion of quartz seems to be liable, in some states, to combine with water; and it then can be acted upon by alkalies and alkaline carbonates. More frequently it is the crystals of felspar, of which granite also consists in a large measure, that decay. These consist of compound silicates, and the alkali among them is generally potash, but occasionally soda. When the alkali is soda, the stone is more likely to decay than when it is potash. Mica or talc, the other constituent of granite, is in a similar way liable to decomposition. Thus, although granite, as a stone, seems scarcely liable to injury, yet all the different parts of it are really capable of decay. With regard to the prevention of granite from decay, I do not know that it has ever been attempted. The only thing to be done is to select the better kinds, and you have only to go to the British Museum, and look at those wonderful specimens which have been delicately sculptured by the Egyptians, and afterwards exposed for so many centuries to a dry atmosphere, and now for some years to our own moist atmosphere, to observe how totally untouched they are. You have only to look at the various specimens of granite in our own metropolis, or in other parts of our island, and you cannot fail of being convinced how well it stands generally, although you may occasionally find unfavorable specimens.

Granite is a material which, owing to its great hardness, requires to be worked by pick and wedge; it cannot be worked merely by chisel and mallet. Owing to that it is expensive, and, generally speaking, cannot be used for ordinary purposes.

Next we come to the group of freestones. Freestones are either sandstones or limestones. The sandstones form a large group, but they are not very extensively used for the more decorative parts of buildings. They are at any rate little used in London, and there are many reasons for this. Sandstone consists for the most part of quartz sand, and I have told you that quartz forms a larger part of granite. But the particles of quartz in sandstone are cemented together by some foreign combining substance; sometimes this substance is silica, and in that case the stone will be almost unchangeable. Such is the sandstone that is worked in Edinburgh, and obtained at Craigleith. It is a stone which scarcely injures by exposure. Most of the sandstones, however, are cemented together, either by carbonate of lime, which has been filtered in by the action of water, by a mixture of clay and carbonate of lime introduced in the same manner, or by the presence of oxide of iron. All these cementing media are of course liable to the action of foreign substances upon them, according to their nature. And if these give way it is clear that the stone itself must give way. For an example of this kind of stone, that scarcely changes at all, I may direct your attention to a few specimens of the Yorkshire stones on the table before you. Although very excellent, however, these stones are not very manageable. They are difficult to work, and very hard. Although very durable, they vary, and are not quite free from the ordinary faults of sandstone. There is also before you a specimen of red stone (Mansfield) in which there is a considerable quantity of iron. The others are silica, with some mica, and are cemented by calcareous and argillaceous matter. They are thus liable to the ordinary action of weather and foreign substances upon them. In these stones the particles of silica rarely, if ever, give way, but they are liable to fall away from each other by the decomposition of their cementing medium. But I was going to speak of the several kinds of sandstone before going into the causes of decay. The Yorkshire stones are the next in value after Craigleith, and are very good. Some of the dark-colored Scotch stones are also excellent. The stones from the coal measures are better than these red ones, which are not by any means advisable, and require to be used with care. There are a number of varieties of these red sandstones. All the sandstones used may be grouped in these three ways:—Those that are very hard, very compact, very fine in grain, and, generally speaking, of a pale color; these are durable but costly. Next, there are those that are hard and laminated. That is the character which belongs to almost all rocks that have been found in water, but in some it shows itself more markedly than in others. In stones which are completely laminated, the appearance is like sheets of paper placed one over the other, and you can almost separate them. Those stones are easily perishable. There are, however, laminated stones, such as those I am now referring to, of good quality. These are generally, not of very fine grain, although they may be so. They are most frequently of a mixed grain, made up of particles of sand and small pebbles of different sizes. Very often they have reddish tints of color, owing to the presence of iron, and they are often very irregular in their character. Lastly, there are some soft stones which are laminated, and generally red, but soft and bad. These are the three kinds of stone.

All these stones are subject to decay in this way:—First, from the lamination. Having been formed in water, they have been deposited in beds one over the other, and never become entirely free from water, and when exposed to the air are liable to give off the water by evaporation, and take it in again by absorption when rain comes, or when the atmosphere is damp. After this, if a change of temperature follows, and a severe cold sets in, the temperature of the stone passing below the point of the extreme density of water, the water begins to expand. That expansion before and whilst freezing, is one of the properties of water with which you are probably acquainted. You all know that if you leave water in a jug with a narrow neck, and frost sets in, the water will expand and break the jug. In the same way laminated and absorbent stones will break. The water gets in but cannot get out freely. It expands, and the stone breaks. Secondly, water entering in the manner I have described contains foreign substances. The water in the atmosphere that falls in the shape of rain is absorbed into the stone, and necessarily contains those foreign substances floating in the atmosphere which are soluble in water. These substances include a large number of gases—acid gases for the most part—but some others. For example, they include carbonic acid gas, and carbonic acid dissolves in water; they include, also, sulphurous acid passing into sulphuric acid, and this is taken up by the water. They include, also, ammonia. All these substances are abundantly produced in the atmosphere of large towns. These substances entering into the body of the stone, begin to act upon the cementing medium. If the cementing medium is easily acted on chemically by these substances, it is of course very soon removed. If it is not easily affected by them, then the stone remains unaltered; but, generally speaking, it is the case that sandstones that have either lime or clay as their cementing medium, are more or less affected by foreign substances entering into them through the atmosphere. There is then a cause of decay in the sandstones, and the sandstones, when they are very absorbent, generally become readily disintegrated in this manner. Sandstones are not very extensively used in London for building, but they are very much employed in many parts of the country.

The next group includes what we call limestones. Limestones differ more in their nature than sandstones do, and include different kinds of material. For example, there are the carbonates of lime pure and the carbonates of lime and magnesia. First of all, I will take the carbonates of lime. Some of these are perfectly crystalline, such as marble. Marble has a very close texture; it does not absorb water, and it is, therefore, little acted upon by it unless it contains acids. When sound it lasts a long time, but if cracked, decay will enter in where the crack occurs. Marble is a very expensive stone, and the quantity of it compared with the other kinds of limestone is small; but there is a good deal of a sort of limestone intermediate between marble and common oolites. This is generally hard, and not unfrequently contains thin strings of foreign substances, as silica, which interfere with its working. Such stones are found in Derbyshire, and belong to what geologists call the carboniferous or mountain limestone series. They are crystalline, but irregular, being partially cracked and containing many fossils. A large majority of the limestones used in this country are oolites, so called because they appear to be made up of a number of eggs. These oolites are of various qualities. They are found in many parts of the country, and are commonly used for building, being, in fact, our common materials. There are several varieties of them which are of different value. One of the best is the Portland stone. There is a specimen upon the table, and a very good specimen it is. These stones are made up of a number of little particles, which are themselves groups of smaller particles. These little particles are cemented together by carbonate of lime, and the whole stone is nearly pure carbonate of lime. Portland is probably the best building stone we have in England, but is dear, being hard and expensive to work. St. Paul's Cathedral is built of Portland stone, and so is Greenwich Hospital, both being excellent examples. It is impossible, perhaps, to find better specimens of this stone than the Hospital. A few days before his death, I was with Sir Charles Barry at Greenwich Hospital, and he was pointing out to me the beautiful condition of the stone on the east face. It is, indeed, worth looking at as a specimen of the material, and is almost, if not quite, equal to the marble of which the Milan Cathedral is built. There are many other good specimens of this stone in London, and of these the Reform Club is as good as any. If you look at these specimens of the better kind, you will hardly recognise the decay that takes place. You must look at stones which have been a long time exposed, or else at an inferior quality of material. Bath stones offer a wonderful contrast to Portland. Bath stone is almost as soft as cheese in the quarry, and it can then be cut with an ordinary knife. I speak now of the stones in the quarry, where all stones are softer and more easily worked than when they have been exposed for some time to the air. Bath stone, being exceedingly soft, is therefore cheap. It is easily got and easily cut, but it is not a stone that wears well. Some specimens of Bath stone are to be seen in the recent restorations of Westminster Abbey that have failed so completely as to be already a great deal worse than much of the stone that has been there for centuries. Within the few years that have elapsed since this stone was put up, it has decayed entirely. And yet stones of the same kind, from nearly the same quarry—indeed some from the identical quarries—have been used in the City of Bath, and are not much the worse after a century's wear. There is a difference in the quality of the stone, but there is also a great difference in the quality of the air to which stones are exposed. The rapid decay may, however, be partly attributed to the fact that the stones for Westminster Abbey had not been well selected, and perhaps the stones used at Bath had been for some time exposed to the air before use. Bath stone is, as I have said, an exact opposite to Portland. But we have other stones that are bad. I do not know that I can mention a more remarkable instance than the stone which is obtained at Heddington, in the neighborhood of Oxford. There are some specimens of the different oolites on the table, and the Heddington is in some respects the worst of all. No one, I think, can have looked at some of the older buildings in Oxford without seeing what a bad state they are in, and how bad the stone itself must be. I have here a specimen of Heddington stone, that has been exposed for a short time to the action of acids, and it shows the way in which such stones will decay. Besides these there are a number of stones of intermediate quality in England, known by various names—the names of the quarries in which they are found. There is the Ancaster stone, the Ketton stone, the Barnack stone, and the Purbeck stone. There is another limestone to which I wish to direct your attention—that is the Caen stone. A vast quantity of stone has been obtained, from time immemorial, from some of the quarries in the neighborhood of Caen, and some other places near. This stone has been brought over to England almost from the time of the Norman conquest. Part of Canterbury Cathedral is built of it, and it has stood very well. But other stones from the same or from adjacent quarries have gone entirely. They have failed so thoroughly that it is impossible to conceive any thing worse. They are even worse than the Heddington stone in the worst cases in Oxford. There is a specimen before me of Caen stone showing decay; it shows the quality of the stone, and it shows the way in which decay takes place. This, however, although a decayed stone, is not a bad specimen. I could not get the sort of specimen I should have been glad of, to show how badly some Caen stone decays. But there have been some buildings erected lately in London, and I am sorry to say that one of them is Buckingham Palace, that show the decay as clearly as can be. Soon after the palace was completed, the stone became in so bad a state that it was positively dangerous for the sentinels to walk underneath it, and it was necessary to remove large portions of it and to substitute stucco; and there it remains to this day painted over. This case, with regard to a common limestone will show what sort of material we have to deal with. All the cheaper kinds of stone are exceedingly liable to decay.

How does limestone decay? It decays in a very simple way, and from the same causes that I alluded to in speaking of sandstones.—First there is an exposure to changing temperature, all the limestones being absorbent, and taking in a certain quantity of water. The water is driven in by rain, particularly in what appear to be the sheltered parts of the stone, beneath projections. Then cold comes, and even if the stone has been placed in the building as it lays in the bed, there will still be a tendency to throw off successive laminæ, but if put carelessly in the building, or fixed at right angles to the position it was in the bed, so that what was originally the plane of the bed has now become vertical, the effect will be that the whole face of the stone will peal off, and if the stone is cut into delicate ornaments, it is almost inevitable that some of the planes of the bed would interfere, so that when expansion takes place, the outer laminæ of the ornament would break off and fall away. The moment that is done in any one place, absorption becomes more rapid than it was before, and it goes on with increasing rapidity. If, however, the stone lasts for a certain time without injury, the surface hardens. All stone is much harder after it has been exposed to the air for some time than it is in the quarry; and, therefore, if it once gets into this state it may last, but if it is attacked early it will go. There is an instance of this to be seen in Mr. Hope's house, in Piccadilly, which is built of a soft stone. It has been sheltered by putting leads over the tops of the exposed parts; and I have Mr. Charles Smith's authority for saying that, in consequence of that, the stone has been preserved. The water has been prevented from draining down into the stone, and in that way it has had time to harden. The water that is absorbed when limestone is exposed to the air is charged with acids, as I have already mentioned, and under these circumstances the stone acts as a kind of filter. A porous stone acts also in another way, decomposing the gases that pass into it. A certain, though slow, decomposition thus goes on, and the stone becomes actually destroyed. Very often this will take place even when it is not very apparent outside. That is the case especially in some of the Heddington stones. At Oxford you will often see large scales breaking off from the surface of the building, although the outside is apparently pretty good. This is the result of that amount of decomposition and alteration that goes on within the substance of the stone itself.

There is another kind of limestone which I must mention. It is magnesian limestone. The magnesian limestone is carbonate of lime and magnesia; common limestone is simply carbonate of lime. Just as the common limestone when crystallized is very durable, so magnesian limestone, when crystallized (in which case it is composed of equal parts of carbonate of lime and carbonate of magnesia), is in a more compact state than when earthy, and then seems to stand exceedingly well. In the places where these stones are obtained, the churches built of them centuries ago are quite unaltered. But when these same stones are brought into our London atmosphere, although they appear to be just as good, and are exposed to very much the same influences, they begin at once to decay. It was owing to a neglect of the consideration of this matter that the stone used for the construction of the Houses of Parliament has suffered so much. The stone for this purpose was selected with the greatest possible consideration. A commission was appointed of the fittest men of the time—the best geologist, the architect, competent practical men, and the best chemists. All those employed were men of the highest reputation, and no one has hinted for a moment that they did not do their duty. This commission examined the different limestones in the country, and they recommended the magnesian limestone of Bolstover, because they believed it to be the best. They found buildings constructed of it many centuries ago entirely unaltered, and they naturally recommended that it should be employed. Then came a difficulty which had not been considered sufficiently, and that was that the particular quarries which had supplied the stone to the churches in the neighborhood were by no means large enough to supply the quantity required for the Houses of Parliament; and not only that, but it was not at all certain that other stones could be got in the immediate neighborhood of precisely the same kind. Other quarries adjacent were selected, and the stone which was used was certainly from the neighborhood, and nominally the same stone, but really it was exceedingly imperfect. Magnesian limestone differs from common limestone in the way in which it decays. Under the action of those causes that I have already mentioned, it decays whenever the two minerals are not perfectly crystallized together, and then it becomes disintegrated and powdery, so that in one block you will find portions which are perfectly hard, and other portions near them, which are also hard, whilst between these two you will find portions which are perfectly soft, and so disintegrated that the particles might almost be blown away by the wind. This has arisen from the way in which the material was originally crystallized, and from the difficulty that there is in producing a perfect crystallization in a mass on a large scale in nature. Generally speaking, there is a considerable amount of variety both in the composition and subsequent metamorphosis of rocks, so that bedded materials almost always vary a great deal even in a short distance. This is the case with magnesian limestone, but it also appears that neglect was incurred by the want of sufficient superintendence in selecting the best kinds of stone, and rejecting bad samples either at the quarry or in London. There was no sufficient superintendence, and the poor and inferior specimens of stone were not rejected. They were all put into this great building, and the result is that some of the stones are very good, some very indifferent, and some exceedingly bad. The same kind of stone was used in the new building of Lincoln's-inn, and it is even worse. The same kind of stone, however, is used in the construction of the Museum of Practical Geology, in Jermyn-street, and there there is not a stone faulty. It would appear then that the selection of stone is a very important matter. So much I may say with regard to the materials and the nature of the causes that produce their decay.

Practically, then, the causes of decay of absorbent stones are connected with exposure to damp atmosphere, rendered impure by various acids and alkaline gases, and also with changes of temperature, especially above and below the temperature of about 38 degrees, at which water attains its greatest density. It is quite clear that where there is a large amount of injurious gases present in the air, in other words in and near large cities, where there are a great number of people breathing and giving off carbonic acid gas, and where a large number of fires are burning, which always yield a large quantity of sulphurous acid, and also where there is much ammonia; in these places, and owing to the state of the atmosphere, stones which in the open country would stand perfectly well, will stand very badly. In addition to this must be taken into account the exposure to certain winds, and the action of the weather to a greater or less extent for a limited time.

(To be Continued.)

MECHANICS, PHYSICS, AND CHEMISTRY.

*The Mechanical Theory of Heat.** By Daniel K. Clark, C. E.

An important an interesting inquiry relative to steam and its operation in the steam engine, is that which traces the connexion between the heat expended and the dynamical effect, or work, produced. The method of separate condensation, and the application of the force of expanding steam, changed to an important extent the accepted relations of heat to power, and added remarkably to the dynamical effect of the fuel; and though the steam engine has been progressively improved by the continual elaboration of small economics, there is yet good reason to believe that the field of improvement is wide, and that the laborer in that field has the prospect of a good return. The inquiries of scientific men on the subject of the relation of heat to mechanical effect have resulted in the establishment of the principle that heat and mechanical force are identical and convertible, and that the action of a given quantity of heat may be represented by a constant quantity of mechanical work performed. "Motion and force," says Professor Rankine, "being the only phenomena of which we thoroughly and exactly know the laws, and mechanics the only complete physical science, it has been the constant endeavor of natural philosophers, by conceiving the other phenomena of nature as modifications of motion and force, to reduce the other physical sciences to branches of mechanics. Newton expresses a wish for the extension of this kind of investigation. The theory of radiant heat and light having been reduced to a branch of mechanics by means of the hypothesis of undulations, it is the object of the hypothesis of molecular vortices"—oscillation of vibratory motion—"to reduce the theory of thermometric heat, and elasticity also, to a branch of mechanics, by so conceiving the molecular structure of matter that the laws of these phenomena shall be the consequences of those of motion and force. This hypothesis, like all others, is neither demonstrably true nor demonstrably false, but merely probable in proportion to the extent of the class of facts with which its consequences agree." It must, however, be remarked that, whether the hypothesis of molecular motion be probable or improbable, the theoretical and practical results arrived at in regard to the mechanical action of heat remaining unaffected, being deduced from principles which have been established by experiment and demonstration. From these principles, Professor Rankine announced the specific heat of air before it was otherwise known—the accuracy of his deductions having since been verified to within less than 1 per cent. by the experiments of Regnault. The best experiments, previous to those made by Regnault, in regard to the specific heat of air, were those of Delaroche and Berard, from which they deduced a specific heat of ·266; but arguing from the mechanical theory of heat, Professor Rankine declared that this value must be erroneous, and that the specific heat of air could not exceed ·240. It has been found accordingly, by Regnault, since the statement was made, as the result of a hundred experiments, that the specific heat of air was ·238, and that it is constant for all pressures from one to ten atmospheres, or at least differs almost inappreciably. This coincidence of theoretical prediction with experimental evidence, it has been well observed, should have something like the same tendency in strengthening our belief of the theory upon which Prof. Rankine's estimate was based, as the discovery of an unknown planet, previously indicated by Le Verrier and Adams, had in confirming our faith in the science of astronomy.

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*From the Lond. Engineer, No. 232.

The principle of the dynamical or mechanical theory of heat, as already stated, is that, independently of the medium through which heat may be developed into mechanical action, the same quantity of heat converted is invariably resolved in the same total quantity of mechanical action. For the exact expression of this relation, of course units of measure are established, in terms of the English foot, as the measure of space; the pound avoirdupois, as the measure of weight, pressure, elasticity; and the degree of Fahrenheit's scale, as the measure of temperature and heat. Work done consists of the exertion of pressure through space, and the English unit of work is the exertion of 1 ℔. of pressure through 1 ft., or the raising of 1 ℔. weight through a vertical height of 1 ft.—briefly, a foot-pound. The unit of heat is that which raises the temperature of 1 ℔. of ordinary cold water by 1 deg. Fah. If 2 ℔s. of water be raised 1 deg., or 1 ℔. be raised 2 deg. in temperature, the expenditure of heat is, equally in both cases, two units of heat. Similarly, if 1 lb. weight be raised through 1 ft., or 2 lbs. weight be raised through 2 ft., the power expended, or work done, is equally in both cases two units of work, or two foot-pounds. From these definitions, then, the comparison lies between the unit of heat, on the one part, and the unit of work, or the foot-pound, on the other. M. Clapeyron, in his treatise on the moving power of heat, and M. Noltzman, of Manheim, in 1845, who availed himself of the labors of M. Clapeyron and M. Carnot in the same field, grounding their investigations on the received laws of Boyle or Marriotte, and Gay-Lussac, which express the observed relations of heat, elasticity, and volume in steam and other gaseous matter, concluded that the unit of heat was capable of raising a weight, between the limits of 626 lbs. and 782 lbs. 1 ft. high; that is to say, that one unit of heat was equivalent to from 626 to 782 foot-pounds. By this mode of investigation, they suppose a given weight of steam or gaseous matter to be contained in a vertical cylinder formed of non-conducting material, in which is fitted an air-tight but freely moving piston, which is pressed downward by a weight equal to the elasticity of the gas. Now, the weight, initial temperature, pressure, and volume being known, a definite quantity of heat from without is supposed to be imparted to the vapor; and the result is partly an elevation of the temperature of the vapor, and partly a dilation or increase of volume; or, in other words, an exertion of pressure through space, the elasticity remaining the same. But the result may be represented entirely by dilation, so that there shall not be any final alteration of temperature; and for this purpose it is only necessary to allow the vapor to dilate without any loss of its original or imparted heat until it re-acquires its initial temperature. In this case, the ultimate effect is purely dilatation, or motion against pressure; and the work done is represented by the product of that pressure into the space moved through.

Mr. Joule, of Manchester, in 1843–47, proceeded, by entirely different, independent, and, in fact, purely experimental methods, to investigate the relation of heat and work. 1st. By observing the calorific effects of magneto-electricity. He caused to revolve a small compound electro-magnet immersed in a glass vessel containing water between the poles of a powerful magnet: heat was proved to be excited by the machine by the change of temperature in the water surrounding it, and its mechanical effect was measured by the motion of such weights as by their descent were sufficient to keep the machine in motion at any assigned velocity. 2d. By observing the changes of temperature produced by the rarefaction and condensation of air. In this case, the mechanical force producing compression being known, the heat excited was measured by observing the changes of temperature of the water in which the condensing apparatus was immersed. 3d. By observing the heat evolved by the friction of fluids: A brass paddle-wheel, in a copper can containing the fluid, was made to revolve by descending weights. Sperm oil and water yielded the same results. Mr. Joule considered the third method the most likely to afford accurate results; and he arrived at the conclusion that one unit of heat was capable of raising 772 lbs. 1 ft. in height; or that the mechanical equivalent of heat was expressible by 772 foot-pounds for one unit of heat—known as "Joule's equivalent."

The following are the values of Joule's equivalent for different thermometric scales, and in English and French units:—

1 English thermal unit, or 1 deg. Fah. in 1 lb. of water,	772 foot-pounds.
1 centigrade degree in 1 lb. of water, . . .	1389 6 "
1 French thermal unit, or 1 centigrade degree in a kilogramme of water, ...	423·55 kilogrammetres.

The mechanical theory of heat rests upon a wide basis, and proofs in verification of the theory are constantly accumulating. When the weight of any liquid whatever is known, with the comparative weight of its vapor at different pressures, the latent heat at the different pressures is readily estimated from the theory; and this method of estimation agrees with the best experimental results, as may afterwards be shown; and when the latent heat is also known, the specific heat of the liquid can be determined by means of the same theory; in other words, the quantity of work, in foot-pounds, may be determined, which would, by agitating the liquid or by friction, be required to raise the temperature of any given quantity of the liquid by, say, one degree, altogether independently of Joule's experiments. The theory enables us to discover the utmost power it is possible to realize from the combination of any given weight of carbon and oxgyen, or other elementary substances, with nearly as much precision as we can estimate the utmost quantity of work it is possible to obtain from a known weight of water falling through a given height. It is not difficult to comprehend, then, that the theory of the mechanical equivalent of heat proves of great practical utility.

According to the mechanical theory of heat, in its general form, heat, mechanical force, electricity, chemical affinity, light, sound, are but different manifestations of motion. Dulong and Gay-Lussac proved by their experiments on sound, that the greater the specific heat of a gas, the more rapid are its atomic vibrations. Elevation of temperature does not alter the rapidity, but increases the length of their vibrations, and in consequence produces "expansion" of the body. All gases and vapors are assumed to consist of numerous small atoms, moving or vibrating in all directions with great rapidity; but the average velocity of these vibrations can be estimated when the pressure and weight of any given volume of gas is known, pressure being, as explained by Joule, the impact of those numerous small atoms striking in all directions, and against the sides of the vessel containing the gas. The greater the number of these atoms, or the greater their aggregate weight, in a given space, and the higher the velocity, the greater is the pressure. A double weight of a perfect gas, when confined in the same space, and vibrating with the same velocity—that is, having the same temperature—gives a double pressure; but the same weight of gas, confined in the same space, will, when the atoms vibrate with a double velocity, give a quadruple pressure. An increase r decrease of temperature is simply an increase or decrease of mole-ular motion. The truth of this hypothesis is very well established, s already intimated, by the numerous experimental facts with which t is in harmony.

When a gas is confined in a cylinder under a piston, so long as no otion is given to the piston, the atoms, in striking, will rebound from he piston after impact with the same velocity with which they ap-roached it, and no motion will be lost by the atoms. But when the iston yields to the pressure, the atoms will not rebound from it with he same velocity with which they strike, but will return after each ucceeding blow, with a velocity continually decreasing as the piston ontinues to recede, and the length of the vibrations will be diminished. he motion gained by the piston will, it is obvious, be precisely equi-alent to the energy, heat, or molecular motion lost by the atoms of he gas. Vibratory motion or heat being converted into its equivalent f onward motion, or dynamical effect, the conversion of heat into ower, or of power into heat, is thus simply a transference of motion; nd it would be as reasonable to expect one billiard-ball to strike and ive motion to another without losing any of its own motion, as to uppose that the piston of a steam engine can be set in motion with-ut a corresponding quantity of energy being lost by some other body.

In expanding air spontaneously to a double volume, delivering it, ay, into a vacuous space, it has been proved repeatedly that the air oes not fall appreciably in temperature, no external work being per-ormed; but, on the contrary, if the air at a temperature, say, of 230 eg. Fah., be expanded under pressure or resistance, as against the iston of a cylinder, giving motion to it, raising a weight, or other-ise doing work by giving motion to some other body, the tempera-ure will fall nearly 170 deg. when the volume is doubled; that is, rom 230 deg. to about 60 deg., and taking the initial pressure of 40 bs., the final pressure would be 15 ℔s. per square inch.

When a pound weight of air, in expanding at any temperature or ressure, raises 130 ℔s. 1 ft. high, it loses 1 deg. in temperature; in ther words, this pound of air would lose as much molecular energy s would equal the energy acquired by a weight of 1 ℔. falling through height of 130 ft. It must, however, be remarked that but a small ortion of this work, 130 foot-pounds can be had as available work, s the heat which disappears does not depend on the amount of work r duty realized, but upon the total of the opposing forces, including ll resistance from any external source whatever. When air is com-ressed, the atmosphere descends and follows the piston, assisting in he operation with its whole weight; and when air is expanded, the otion of the piston is, on the contrary, opposed by the whole weight f the atmosphere, which is again elevated. Although, therefore, in xpanding air, the heat which disappears is in proportion to the total pposing force, it is much in excess of what can be rendered avail-ble; and, commonly, where air is compressed the heat generated is uch greater than that which is due to the work which is required to e expended, the weight of the atmosphere assisting in the operation.

Let a pound of water, at a temperature of 212 deg. Fah., be injected into a vacuous space or vessel, having 26·36 cubic feet of capacity—the volume of 1 ℔. of saturated steam at that temperature—and let it be evaporated into such steam, then 893·8 units of heat would be expended in the process. But if a second pound of water, at 212 deg., be injected and evaporated at the same temperature, under a uniform pressure of 14·7 ℔s. per square inch due to the temperature, the second pound must dislodge the first, by repelling that pressure, involving an amount of labor equal to 55,800 foot-pounds (that is, 14·7 ℔s. × 144 square inches × 26·36 cubic feet), and an additional expenditure of 72·3 units of heat (that is, 55,800 ÷ 772), making a total for the second pound of 965·1 units.

Similarly, when 1408 units of heat are expended in raising the temperature of air at constant pressure, 1000 of the units increase the velocity of the molecules, or produce a sensible increment of temperature; while the remaining 408 parts, which disappear as the air expands, are directly expended in repelling the external pressure.

Again, if steam be permitted to flow from a boiler into a comparatively vacuous space, without giving motion to another body, the temperature of the steam entering this space would rise much higher than that of the steam in the boiler. Or, suppose two vessels side by side, one of them vacuous, and the other filled with air at, say, two atmospheres, a communication being opened between the vessels, the pressure would become equal in the two vessels; but the temperature would fall in one vessel and rise in the other; and although the air is expanded in this manner to a double volume, there would not on the whole be any appreciable loss of heat, for if the separate portions of air be mixed together, the resulting average temperature of the whole would be very nearly the same as at first. It has been proved experimentally, corroborative of this argument, that the quantity of heat required to raise the temperature of a given weight of air to a given extent, was the same, irrespective of the density or volume of the air. Regnault and Joule found that, to raise the temperature of a pound weight of air 1 cubic foot in volume, or 10 cubic feet, the same quantity of heat was expended.

In rising against the force of gravity steam becomes colder, and partially condenses while ascending in the effort of overcoming the resistance of gravity by the conversion of heat into water. For instance, a column of steam weighing, on a square inch of base, 250·3 ℔s.—that is, a pressure of 250·3 ℔s. per square inch—would, at a height of 275,000 feet, be reduced to a pressure of 1 ℔. per square inch, and in ascending to this height, the temperature would fall from 401 deg. to 102 deg. Fah., while at the same time, nearly 25 per cent. of the whole vapor would be precipitated in the form of water, if not supplied with heat while ascending.

If a body of compressed air be allowed to rush freely into the atmosphere, the temperature falls in the rapid part of the current by the conversion of heat into motion, but the heat is almost all reproduced when the motion is quite subsided; and from recent experiments it appears that nearly similar results are obtained from the emission of steam under pressure.

When water falls through a gaseous atmosphere its motion is constantly retarded as it is brought into collision with the particles of that atmosphere, and by this collision it is partly heated and partly converted into vapor.

If a body of water descends freely through a height of 772 ft., it acquires from gravity a velocity of 223 ft. per second; and if suddenly brought to rest when moving with this velocity, it would be violently agitated, and raised 1 degree in temperature. But suppose a water-wheel, 772 ft. in diameter, into the buckets of which water is quietly dropped, when the water descends to the foot of the fall, and is delivered gently into the tail-race, it is not sensibly heated. The greatest amount of work it is possible to obtain from water falling from one level to another lower level is expressible by the weight of water multiplied by the height of the fall.

The object of these illustrative exhibitions of the nature and reciprocal action of heat and motive power, with their relations, are—first, to familiarize the reader with the doctrine of the mechanical equivalence of heat; second, to show that the nature and extent of the change of temperature of a gas while expanding, depends nearly altogether upon the circumstances under which the change of volume takes place.

A Course of Lectures, consisting of Illustrations of the Various Forces of Matter, i.e. *of such as are called the Physical or Inorganic Forces.**

By M. Faraday, D. C. L., F. R. S.

Lecture III. (Jan. 4, 1860.)—*Cohesion.—Chemical Affinity.*

We will first of all return for a few minutes to one of the experiments which we made yesterday. You remember what we put together on that occasion?—Powdered alum and warm water; here is one of those basins; nothing has been done to it since then, but you will find on examining it that it no longer contains any powder, but a multitude of beautiful crystals. Here also are the pieces of coke which I put into the other basin; these have a fine mass of crystals about them. That other basin I will leave as it is; I will not pour the water from it, because it will show you that the particles of alum have done something more than merely crystallize together. They have pushed the dirty matter from them, laying it around the outside or outer edge of the lower crystals—squeezed out, as it were, by the strong attraction which the particles of alum have for each other.

And now for another experiment. We have already gained a knowledge of the manner in which the particles of bodies—of solid bodies—attract each other, and we know that it makes calcareous spar, alum, and so forth, crystallize in these regular forms. Now, let me gradually lead your minds to a knowledge of the means we have of making this attraction alter a little in its force; either of increasing or diminishing, or apparently of destroying it altogether. I will take this piece of iron [a rod of iron about two feet long and a quarter of an inch in diameter], it has at present a great deal of strength, due to its attraction of cohesion; but if Mr. Anderson will make part of this rod hot in the fire, we shall then find that it will become soft, just as sealing-wax will when heated, and we shall also find that the more it is heated the softer it becomes. Ah! but what does *soft* mean? Why, that the attraction between the particles is so weakened that it is no longer sufficient to resist the power we bring to bear upon it. [Mr. Anderson handed to the Lecturer the iron rod, with one end red hot, which he showed could be easily twisted about with a pair of pliers.] You see, I now find no difficulty in bending this end about how I like; whereas I cannot bend the cold part at all. And you know how the smith takes a piece of iron and heats it, in order to render it soft for his purpose; he acts upon our principle of lessening the adhesion of the particles, although he does not know exactly the terms in which we express it.

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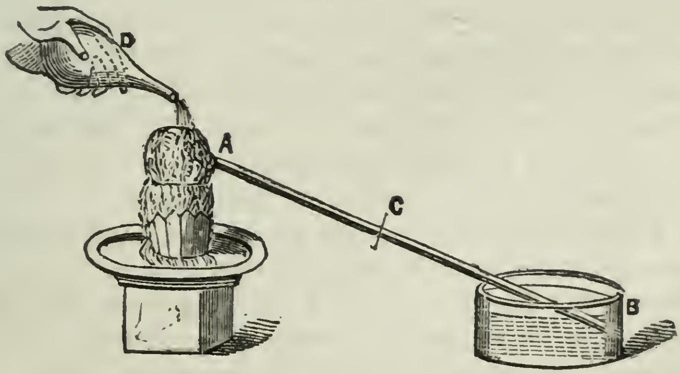
* From the Lond. Chemical News, No. 7.

And now we have another point to examine; and this water is again a very good substance to take as an illustration (as philosophers we call it all water, even though it be in the form of ice or steam). Why is this water hard? [pointing to a block of ice] because the attraction of the particles to each other is sufficient to make them retain their place in opposition to force applied to it. But what happens when we make the ice warm? Why, in that case we diminish to such a large extent the power of attraction that the solid substance is destroyed altogether. Let me illustrate this: I will take a red-hot ball of iron [Mr. Anderson, by means of a pair of tongs, handed to the Lecturer a red-hot ball of iron, about two inches diameter] because it will serve as a convenient source of heat [placing the red-hot iron in the centre of the block of ice]. You see I am now melting the ice where the iron touches it. You see the iron sinking into it, and while part of the solid water is becoming liquid, the heat of the ball is rapidly going off. A certain part of the water is actually rising in steam—the attraction of some of the particles is so much diminished that they cannot even hold together in the liquid form, but escape as vapor. At the same time you see I cannot melt all this ice by the heat contained in this ball. In the course of a very short time I shall find it quite cold.

Here is the water which we have produced by destroying some of the attraction which existed between the particles of the ice, for below a certain temperature the particles of water increase in their mutual attraction and become ice; and above a certain temperature the attraction decreases and the water becomes steam. And exactly the same thing takes place with platinum, and nearly every substance in nature; if the temperature is increased to a certain point it becomes liquid, and a further increase makes it a gas. Is it not a glorious thing for us to look at the sea, the rivers, and so forth, and to know that this same body in the northern regions is all solid ice and ice-bergs, while here in a warmer climate it has its attraction of cohesion so much diminished as to be liquid water? Well, in diminishing this force of attraction between the particles of ice, we made use of another force, namely, that of *heat*, and I want you now to understand that this force of heat is always concerned when water passes from the solid to the liquid state. If I melt ice in *other* ways I cannot do without heat; (for we have the means of making ice liquid without heat; that is to say, without using heat as a *direct* cause.) Suppose, for illustration, I make a vessel out of this piece of tin-foil [bending the foil up into the shape of a dish]. I am making it metallic, because I want the heat which I am about to deal with to pass readily through it;—and I am going to pour a little water on this board, and then place the tin vessel on it. Now if I put some of this ice into the metal dish, and then proceed to make it liquid by any of the various means we have at our command, it still must take the necessary quantity of heat from something, and in this case, it will take the heat from the tray, and from the water underneath, and from the other things round about. Well, a little salt added to the ice has the power of causing it to melt, and we shall very shortly see the mixture become quite fluid, and you will then find that the water beneath will be frozen—frozen because it has been forced to give up that heat which is necessary to keep it in the liquid state, to the ice on becoming liquid. I remember once, when I was a boy, hearing of a trick in a country ale-house; the point was how to melt ice in a quart pot by the fire, and freeze it to the stool. Well, the way they did it was this: they put some pounded ice in a pewter pot and added some salt to it, and the consequence was that when the salt was mixed with it, the ice in the pot melted (they did not tell me anything about the salt, and they set the pot by the fire, just to make the result more mysterious), and in a short time the pot and the stool were frozen together, as we shall very shortly find it to be the case here, and all because salt has the power of lessening the attraction between the particles of ice. Here you see the tin dish is frozen to the board, I can even lift this little stool up by it.

This experiment then cannot, I think, fail to impress upon your minds the fact, that whenever a solid body loses some of that force of attraction by means of which it remains solid, heat is absorbed; and if, on the other hand we convert a liquid into a solid, *e.g.*, water into ice, a corresponding amount of heat is given out. I think an experi-

Fig. 1.

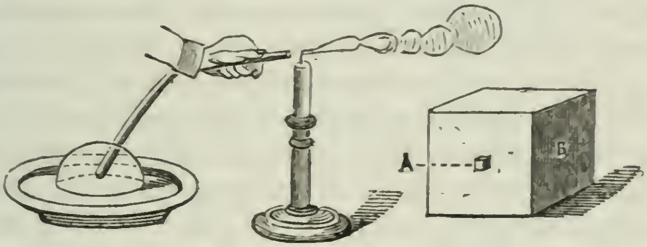


ment of this kind will serve to show you this. Here (Fig. 1) is a bulb A, filled with air, the tube from which dips into some colored liquid in the vessel B. And I dare say you know that if I put my hand on the bulb A, and warm it, the colored liquid which is now standing in the tube at C will travel forward. Now we have discovered a means, by great care and research into the properties of various bodies, of preparing a solution of a salt which if shaken or disturbed will at once become a solid; and as I explained to you just now (for what is true of water is true of every other liquid), by reason of its becoming solid, heat is evolved, and I can make this evident to you by pouring it over this bulb;—there! it is becoming solid, and look at the colored liquid, how it is being driven down the tube, and how it is bubbling out through the water at the end; and so we learn this beautiful law of our philosophy, that whenever we diminish the attraction of cohesion we absorb heat—and whenever we increase that attraction heat is evolved. This, then, is a great step in advance, for you have learned a great deal in addition to the mere circumstance that particles attract each other. But you must not now suppose that because they are liquid they have lost their attraction of cohesion; for here is the fluid mercury, and if I pour it from one vessel into another I find that it will form a stream from the bottle down to the glass—a continuous rod of fluid mercury, the particles of which have attraction sufficient to make them hold together all the way through the air down to the glass itself; and if I pour water quietly from a jug I can cause it to run in a continuous stream in the same manner. Again, let me put a little water on this piece of plate glass, and then take another plate of glass and put it on the water; there! the upper plate is quite free to move, gliding about on the lower one from side to side; and yet, if I take hold of the upper plate and lift it up straight, the cohesion is so great that the lower one is held up by it. See how it runs about it as I move the upper one, and this is all owing to the strong attraction of the particles of the water. Let me show you another experiment. Suppose I take a little soap and water—not that the soap makes the particles of the water more adhesive one for the other, but it certainly has the power of continuing in a better manner the attraction of the particles; (and let me advise you, when about to experiment with soap bubbles to take care to have every thing clean and soapy.) I will now blow a bubble, and that I may be able to talk and blow a bubble too, I will take a plate with a little of the soap-suds in it, and will just soap the edges of the pipe, and blow a bubble on to the plate. Now, there is our bubble. Why does it hold together in this manner? Why, because the water of which it is composed has an attraction of particle for particle:—so great, indeed, that it gives to this bubble the very power of an india-rubber ball; for you see, if I introduce one end of this glass tube into the bubble that it has the power of contracting so powerfully as to force enough air through the tube to blow out a light (Fig. 2)—there is a light blown out. And look! see how the bubble is disappearing; see how it is getting smaller and smaller.

There are twenty other experiments I might show you to illustrate his power of the cohesion of the particles of liquids. For instance, vhat would you propose to me, if, having lost the stopper out of this lcohol bottle, I should want to close it speedily with something near t hand. Well, a bit of paper would not do, but a piece of linen cloth vould, or some of this cotton wool which I have here. I will put a uft of it into the neck of the alcohol bottle, and you see when I turn t upside down, that it is perfectly well stoppered so far as the alcohol s concerned; the air can pass through but the alcohol cannot. And f I were to take an oil vessel this plan would do equally well, for in ormer times they used to send us oil from Italy in flasks stoppered nly with cotton wool (at the present time the cotton is put in after he oil has arrived here, but formerly it used to be sent so stoppered). Now if it were not for the particles of liquid cohering together, this lcohol would run out, and if I had time I could have shown you a essel with the top, bottom, and sides altogether formed like a sieve, nd yet it would hold water owing to this cohesion.

You have now seen that the solid water can become fluid by the addition of heat, owing to this lessening the attractive force between its articles, and yet you see that there is a good deal of attractive force emaining behind. I want now to take you a step beyond that. We

Fig. 2. Fig. 3.

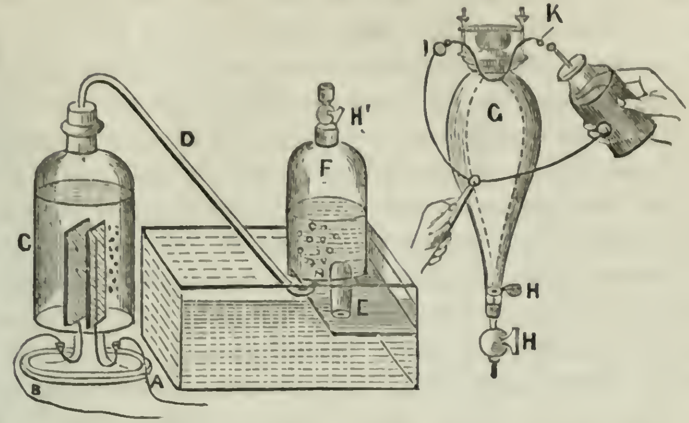


aw that if we continued applying heat to the water (as indeed hapened with our piece of ice here) that we did at last break up that atraction which holds the liquid together, and I am going to take some ther (any other liquid would do, but ether makes a better experiment or my purpose) in order to illustrate what will happen when this coesion is broken up. Now this liquid ether, if exposed to a very low emperature, will become a solid, but if we apply heat to it, it becomes apor, and I want to show you the enormous bulk of the substance in his new form:—when we make ice into water, we lessen its bulk, but vhen we convert water into steam, we increase it to an enormous exent. You see it is very clear that as I apply heat to the liquid I diminish its attraction of cohesion—it is now boiling, and I will set fire o the vapor, so that you may be enabled to judge of the space occuied by the ether in this form by the size of its flame, and you now ee what an enormously bulky flame I get from that small volume of ther below. The heat from the spirit lamp is now being consumed, ot in making the ether any warmer, but in converting it into vapor, nd if I desired to catch this vapor and condense it (as I could without nuch difficulty), I would have to do the same as if I wished to convert steam into water and water into ice; in either case it would be necessary to increase the attraction of the particles, by cold or otherwise. So largely is the bulk occupied by the particles increased by giving them this diminished attraction, that if I were to take a portion of water a cubic inch in bulk (A Fig. 3) I should produce a volume of steam of that size B [1700 cubic inches; nearly a cubic foot], so greatly is the attraction of cohesion diminished by heat; and yet it still remains water. You can easily imagine the consequences which are due to this change in volume by heat—the mighty powers of steam and the tremendous explosions which are sometimes produced by this force of water. I want you now to see another experiment which will perhaps give you a better illustration of the bulk occupied by a body when in the state of vapor. Here is a substance which we call iodine, and I am about to submit this solid body to the same kind of condition as regards heat that I did the water and the ether [putting a few grains of iodine into a hot glass globe, which immediately became filled with the violet vapor], and you see the same kind of change produced. Moreover, it gives us the opportunity of observing how beautiful is the violet-colored vapor from this black substance, or rather the mixture of the vapor with air (for I would not wish you to understand that this globe is entirely filled with the vapor of iodine).

If I had taken mercury and converted it into vapor (as I could easily do), I should have a perfectly colorless vapor, for you must understand this about vapors, that bodies in what we call the vaporous or gaseous state, are always perfectly transparent, never cloudy or smoky; they are, however, often colored, and we can frequently have colored vapors or gases produced by colorless particles themselves mixing together, as in this case [the Lecturer here inverted a glass cylinder full of binoxide of nitrogen over a cylinder of oxygen, when the dark red vapor of hyponitric acid was produced]. Here also you see a very excellent illustration of the effect of some power of nature which we have not yet come to, but which stands next on our list—CHEMICAL AFFINITY. And thus you see we can have a violet vapor or an orange vapor, and different other kinds of vapor, but they are always perfectly transparent, or else they would cease to be vapors.

I am now going to lead you a step beyond this consideration of the attraction of the particles for each other. You see we have come to understand that (to take water as an illustration) whether it be ice, or water, or steam, it is always to be considered by us as water. Well, now prepare your minds to go a little deeper into the subject. We have means of searching into the constitution of water beyond any that are afforded us by the action of heat, and among these one of the most important is that force which we call voltaic electricity, which we used at our last meeting for the purpose of obtaining light, and which we carried about the room by means of these wires. This force is produced by the battery behind me, to which, however, I will not now refer more particularly; before we have done we shall know more about this battery, but it must grow up in our knowledge. Now here (Fig. 4) is a portion of water in this little vessel C, and besides the water there are two plates of the metal platinum, which are connected with the wires A B, coming outside, and I want to examine that water, and the state and the condition in which its particles are arranged. If I were to apply heat to it you know what we should get, it would assume the state of vapor, but it would nevertheless remain water, and would return to the liquid state as soon as the heat was removed. Now by means of these wires (which are connected with the battery behind me, and come under the floor and up through the table) we shall have a certain amount of this new power at our disposal. Here you see it is [causing the ends of the wires to touch]—that is the electric light we used yesterday, and by means of these wires we can cause water to submit itself to this power; for the moment I put them into metallic connexion at A and B, you see the water boiling in that little vessel C, and you hear the bubbling of the gas that is going through the tube D. See how I am converting the water into vapor, and if I take a little vessel E, and fill it with water, and put it in the trough over the end of the tube D, there goes the vapor ascending into the vessel. And yet that is not steam, for you know that if steam is brought near cold water, it would at once condense, and return back again to water; this, then, cannot be steam, for it is bubbling through the cold water in this trough, but it is a vaporous substance, and we must therefore examine it carefully, to see in what way the water has been changed. And now, in order to give you a proof that it is not steam, I am going to show you that it is combustible, for if I take this small vessel to a light, the vapor inside explodes in a manner that steam could never do.

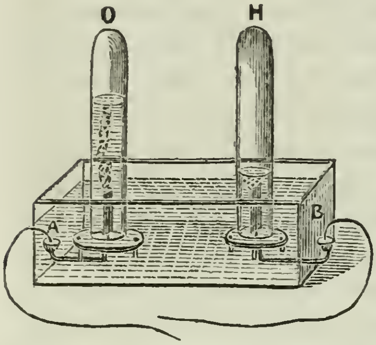
Fig. 4.



I will now fill this large bell-jar F with water; and I propose letting the gas ascend into it, and I will then show you that we can reproduce the water back again from the vapor or air that is there. Here is a strong glass vessel G, and into it we will let the gas from F pass. We will then fire it by the electric spark, and then after the explosion you will find that we have got the water back again; it will not be much, however, for you will recollect that I showed you how small a portion of water produced a very large volume of vapor. Mr. Anderson will now pump all the air out of this vessel G, and when I have screwed it on to the top of our jar of gas F, you will see upon opening the stopcocks H′ H H, the water will jump up, showing that some of the gas has passed into the glass vessel. I will now shut these stop-cocks, and we shall be able to send the electric spark through the gas by means of the wires I K in the upper part of the vessel, and you will see it burn with a most intense flash. [Mr. Anderson here brought a Leyden jar, which he discharged through the confined gas by means of the wires I K.] You saw the flash, and now, that you may see that there is no longer any gas remaining, if I place it over the jar and open the stop-cocks again, up will go the gas, and we can have a second combustion; and so I might go on again and again, and I should continue to accumulate more and more of the water to which the gas has returned. Now is not this curious;—in this vessel C we can go on making from water a large bulk of *permanent gas*, as we call it, and then we can reconvert it into water in this way. [Mr. Anderson brought in another Leyden jar, which, however, from some cause would not ignite the gas. It was therefore recharged, when the explosion took place in the desired manner.] How beautifully we get our results when we are right in our proceedings!—it is not that Nature is wrong when we make a mistake. Now I will lay this vessel G down by my right hand, and you can examine it by-and-by; there is not very much water flowing down, but there is quite sufficient for you to see.

Another wonderful thing about this mode of changing the condition of the water is this—that we are able to get the separate parts of which it is composed, at a distance the one from the other, and to examine them, and see what they are like, and how many of them there are; and for this purpose I have here some more water in a slightly different apparatus to the former one (Fig. 5), and if I place this in connexion with the wires of the battery at A B, I shall get a similar decomposition of the water at the two platinum plates. Now I will put this little tube O over there, and that will collect the gas together that comes from the side A, and this tube H will collect the gas that comes from the other side B, and I think we shall soon be able to see a difference. In this apparatus the wires are a good way apart from each other, and it now seems that *each* of them is capable of drawing off particles from the water and sending them off, and you see that one set of particles, H, is coming off twice as fast as those collected in the other tube O. Something is coming out of the water *there* at H which burns [setting fire to the gas], but what comes out of the water *here* at O, although it will not burn, will support combustion very vigorously [the Lecturer here placed a match with a glowing tip in the gas, when it immediately rekindled].

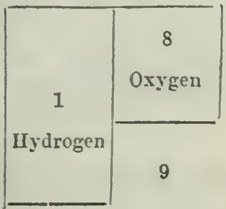
Fig. 5.



Here, then, we have two things, neither of them being water alone, but which we get out of the water. Water is therefore composed of two substances different to itself, which appear at separate places when it is made to submit to the force which I have in these wires, and if I take an inverted tube of water and collect this gas, H, you will see that it is by no means the same as the one we collected in the former apparatus (Fig. 4). That exploded with a loud noise when it was lighted, but this will burn quite noiselessly—it is called *hydrogen;* and the other we call *oxygen*—that gas which so beautifully brightens up all combustion but does not burn of itself. So now we see that water consists of two kinds of particles attracting each other in a very different manner to the attraction of gravitation or cohesion, and this new attraction we call *chemical affinity*, or the force of chemical action between different bodies; we are now no longer concerned with the attraction of iron for iron, water for water, wood for wood, or like bodies for each other, as we were when dealing with the force of cohesion; we are dealing with another kind of attraction,—the attraction between particles of a *different* nature one to the other. Chemical affinity depends entirely upon the energy with which particles of *different* kinds attract each other. Oxygen and hydrogen are particles of different kinds, and it is their attraction to each other which makes them chemically combine and produce water.

I must now show you a little more at large what chemical affinity is. I can prepare these gases from other substances as well as from water; and we will now prepare some oxygen: here is another substance which contains oxygen—chlorate of potash; I will put some of it into this glass retort, and Mr. Anderson will apply heat to it; we have here different jars filled with water, and when by the application of heat the chlorate of potash is decomposed, we will displace the water, and fill the jars with gas.

Now when water is opened out in this way by means of the battery; which adds nothing to it materially, which takes nothing from it materially (I mean no *matter*, I am not speaking of *force*), which adds no *matter* to the water; it is changed in this way—the gas which you saw burning a little while ago, called *hydrogen*, is evolved in large quantity, and the other gas, *oxygen*, is evolved in only half the quantity,



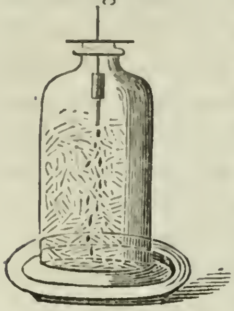
Oxygen, . . .	88·9
Hydrogen, . . .	11·1
Water, . . .	100·0

so that those two areas represent water, and those are always the proportions between the two gases. But oxygen is sixteen times the weight of the other—eight times as heavy as the particles of hydrogen in the water; and you therefore know that water is composed of nine parts by weight—one of hydrogen and eight of oxygen, thus:

Hydrogen, . .	46·2 cub. ins. . .	=1 grain.
Oxygen, . .	23·1 " .	=8 "
Water, . (*steam*)	69·3 " . .	=9 "

Now Mr. Anderson has prepared some oxygen, and we will proceed to examine what is the character of this gas. First of all, you remember I told you that it does not burn, but that it affects the burning of other bodies. I will just set fire to the point of this little bit of wood, and then plunge it into the jar of oxygen, and you will see what this gas does in increasing the brilliancy of the combustion. It does not burn, it does not take fire as the hydrogen would, but how vividly the combustion of the match goes on. Again, if I were to take this wax taper and light it, and turn it upside down in the air, it would, in all probability put itself out, owing to the wax running down into the wick [the Lecturer here turned the lighted taper upside down, when in a few seconds it went out]. Now that will not happen in oxygen gas; you will see how differently it acts (Fig. 6) [the taper was again lighted, turned upside down, and then introduced into a jar of oxygen]. Look at that! see how the very wax itself burns, and falls down in a dazzling stream of fire, so powerfully does the oxygen support combustion. Again, here is another experiment which will serve to illustrate the force, if I may so call it, of oxygen. I have here a circular flame of spirit of wine, and with it I am about to show you the way in which iron burns, because it will serve very well as a comparison between the effect produced by air and oxygen. If I take this ring flame, I can shake, by means of a sieve, the fine particles of iron filings through it, and you will see the way in which they burn [the Lecturer here shook through the flame some iron filings, which took fire and fell through with beautiful scintillations]. But if I now hold the flame over a jar of oxygen [the experiment was repeated over a jar of oxygen, when the combustion of the filings as they fell into the oxygen became almost insupportably brilliant], you see how wonderfully different the effect is in the jar, because there we have oxygen instead of common air.

Fig. 6.



(To be Continued.)

*On the Influence of White Light, of the different Colored Rays, and of Darkness, on the Development, Growth, and Nutrition of Animals.** By HORACE DOBELL, M. D., &c.

The apparatus used in the following experiments was described in my Paper; but in the present instance, only two of the cells were employed, viz: that exposed to ordinary white light, and that from which all light is excluded. In order more effectually to prevent the possible admission of light, the following precautions were adopted with the dark cell:—1. The perforated zinc floor was covered with thick brown paper. 2. The under surface of the lid was lined with black cloth, to secure accurate adjustment when shut. 3. The opaque black glass was covered with an additional coat of black oil-paint. 4. The lid was never opened in any light except that of a candle or of gas.

March 20*th*, 1859.—A number of ova of the silk-worm (*Bombyx mori*), all of the same age, were placed in each of the two cells. No change was observed until *May* 18*th* (sixty days after the commencement of the experiments), when one larva emerged from the ovum in each cell; and during twelve days, larvæ continued to emerge in the light and in the dark at the same rate.

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* From the Lond. Ed. and Dub. Phil. Mag., June, 1860.

June 9*th*.—Sixteen larvæ, as nearly as possible of the same size, were selected in each cell, and the rest removed. The experiments then proceeded with these thirty-two individuals, and no death occurred from first to last.

The following Table shows the day on which each larva began to spin; the day on which the perfect insect escaped from the pupa; and hence the number of days occupied by the metamorphosis.

LIGHT.			DARKNESS.		
Day of beginning to spin.	Day of escape of the Moth.	Number of days occupied by metamorphosis.	Day of beginning to spin.	Day of escape of the Moth.	Number of days occupied by metamorphosis.
July 1	July 18	18 days inclusive	June 30	July 18	19 days inclusive.
“ 2	“ 19	18 “ “	“ 30	“ 18	19 “ “
“ 2	“ 19	18 “ “	“ 30	“ 18	19 “ “
“ 2	“ 18	17 “ “	“ 30	“ 18	19 “ “
“ 2	“ 18	17 “ “	“ 30	“ 21	22 “ “
“ 2	“ 19	18 “ “	July 1	“ 18	18 “ “
“ 2	“ 19	18 “ “	“ 1	“ 18	18 “ “
“ 3	“ 19	17 “ “	“ 2	“ 18	17 “ “
“ 3	“ 21	19 “ “	“ 2	“ 19	18 “ “
“ 4	“ 20	17 “ “	“ 2	“ 20	19 “ “
“ 4	“ 20	17 “ “	“ 2	“ 19	18 “ “
“ 4	“ 20	17 “ “	“ 2	“ 20	19 “ “
“ 4	“ 21	18 “ “	“ 2	“ 21	20 “ “
“ 4	“ 21	18 “ “	“ 3	“ 21	19 “ “
“ 5	“ 21	17 “ “	“ 3	“ 20	18 “ “
“ 6	“ 24	19 “ “	“ 4	“ 21	18 “ “

From this it is seen that the mean period occupied by the metamorphosis in the *darkened cell* was eighteen days fifteen hours, and n the *light cell* seventeen days sixteen hours.

The longest and shortest periods in the *darkened cell*, twenty-two lays and seventeen days, in the *light cell*, nineteen days and seventeen lays.

June 9*th*.—On selection of sixteen of the largest larvæ from the nhabitants of each cell, it was noted that, when sixteen were selected rom the *darkened cell* and several of *similar size* removed, only four ould be found as large in the *white cell;* the remaining twelve selectd were therefore of a rather smaller size. This difference in the two ells became less obvious afterwards, but, throughout the experiments, here was a slight difference of size in favor of the darkened cell.

With these exceptions, no difference could be detected between the esults obtained in the cell from which light was completely excluded nd in that exposed to its full influence.

The larvæ, the silk produced, and the moths from the two cells, hen placed side by side, could not be distinguished from one another.

The ova were of the same color when first deposited, and underwent the same changes of appearance, at the same time, in the dark and in the light.

So far, therefore, as the direct agency of light is concerned in the development, growth, nutrition, and coloration of animals, the results of these experiments closely correspond with those already recorded in my Paper.—*Phil. Mag.* s. 4. vol. xviii, p. 143.

For the Journal of the Franklin Institute.

Observations on the Eclipse of July 17th, 1860.

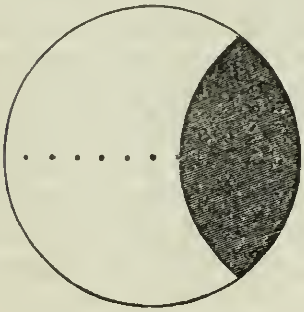
The following observations of the eclipse of the sun, July 17, 1860, were made at Germantown, Penna. Lat. of observatory, 40° 1′ 39″, Long. 5° 0′ 41·9″.

The instrument used was a good refractor, and the time is that shown by an astronomical clock regulated by a transit instrument.

The morning was clear, and in every respect favorable to observation.

Time of first contact,	19^h	5^m	00^s	Thermom. in sun,		96°
Greatest obscuration,	20	4	18·5	"	"	89
End of eclipse,	21	3	37	"	"	106·5

The mean height of the thermometer in the sun during the eclipse, was 101·25°, which point, it is fair to suppose, it would have reached at 20 h. 4 m. 18·5 s. under ordinary circumstances, and therefore that a modification of temperature of 12·25° was produced by the interception of the sun's rays at the middle of the eclipse.



The figure, which is taken from a drawing of the image thrown upon the ground glass of a camera obscura at the time of greatest obscuration, shows five digits eclipsed.

N. B. It may not be amiss in this connexion to make some allusion to the very extraordinary atmospheric phenomenon of Friday evening, the 20th inst.

About 9½ o'clock, P. M., a luminous body nearly the size of the full moon when setting, appeared in the western heavens, at an elevation of about 25°, shedding a brilliant light upon all terrestrial objects. It moved with moderate velocity in a north-easterly direction, preserving its parallelism with the horizon almost throughout its course, upon reaching the centre of which it divided, without any perceptible report however, into several lesser bodies, following each other at short intervals, gradually diminishing and leaving sparks in their train, until lost in the east in one single bright star, about the diameter of the planet Mars, as it now appears.

It is not a little remarkable that, notwithstanding the large number of persons who witnessed this phenomenon, singular coincidence prevailed in their impressions with regard to its magnitude, velocity, duration, &c.: thus contradicting the common assertion that no two men see the same thing alike. W.

Germantown.

Description of a Patent Blast Gas Furnace.[*] By J. J. GRIFFIN, F. C. S.

(Continued from page 101.)

Gas Furnace heated at the bottom.—In this furnace the parts are the same as those marked *a*, *b*, *c*, *d*, *e*, *e*, in Fig. 2; but the gas-burner is in this case put into the bottom of the furnace instead of the top, and the arrangement of the crucible and its support is altered. Upon the centre of the clay plate *d*, the perforated plumbago cylinder and cover, Nos. 5 and 7 are placed; and upon them a plumbago crucible, No. 10. The size of the crucible, and the height of the perforated cylinder, are to be so adjusted that the bottom of the crucible shall be struck by the hottest part of the gas flame; that is to say, the space left between the face of the gas-burner and the bottom of the crucible must not exceed 2½ inches. The crucible is provided with a closely fitting cover, and pebbles are then filled in between the crucible jacket and the furnace cylinder, and are covered over the crucible until both the pieces of the furnace *e e*, are filled. The gas is then lighted, the blast of air is set on, the gas-burner is forced up into the hole in the clay plate *d*, and the operation proceeds. In from ten to twenty minutes after the gas is lighted—this difference of time depending upon the size of the furnace, and the weight of the metal contained in the crucible—the interior of the lower cylinder *e*, acquires a white heat. The progress of the operation can be watched by occasionally removing the stone peg in the trial-hole of the furnace cylinder *e*. The heat very slowly ascends into the upper cylinder, and it never becomes so great in the upper as in the lower cylinder. The greatest fusing power of the furnace is confined within a vertical space of about six inches, reckoning from the bottom. The power of flint pebbles to abstract heat from the gases which pass through this apparatus is quite remarkable. When about six inches of pebbles lie above the crucible, and the crucible and the pebbles about it have been white hot for half an hour, the hand can be held over the top of the furnace, within a few inches of the pebbles, without inconvenience. It becomes wetted with the vapor which rises from the furnace, but feels only a moderate degree of heat.

This form of the furnace is attended by the inconvenience that you cannot examine the condition of the matter contained in the crucible, to ascertain when the heat has been continued long enough. In cases where the fusion is performed repeatedly on the same weight of metal, this would be of no importance, because the power of the furnace is so steady and regular, that the time of firing which has been found to answer once will answer the same purpose again.

When it is supposed that the fusion of the metal submitted to trial is completed, the gas is first to be turned off, and then the supply of air stopped. You can either allow the furnace to remain intact till it is cold, or lift off the cylinders *e e*, with tongs, and allow the hot stones to fall into the iron pan placed below the furnace to receive them. A few bricks should be laid between the pan and the table or stool on which it rests, if the latter is made of wood; because the heat given off by the pebbles is very great. The pebbles being raked away from the crucible, the contents of the latter can be examined.

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[*] From the Lond. Chemical News, No. 4.

The absolute sizes of the furnaces depend upon the amount of work required from them. The fusions described below were mostly made in a furnace of six inches internal diameter, a few in a furnace of four inches internal diameter, and one or two in a furnace of eight inches internal diameter; all of them with a gas-burner of sixteen holes, and a supply of gas obtained from a half-inch pipe. A large furnace with an internal diameter of twelve inches, will demand a gas-burner of twenty-six holes, and a supply of gas from a pipe of nearly one inch in the bore.

Examples of Fusions effected by the Blast Gas Furnace.—The fusing points of certain metals have been fixed by Daniell at the following temperatures:—

Silver, . .	1873° F.	Copper, . .	1996° F.
Gold, . . .	2016°	Cast Iron, . .	2786°

Brass, with 25 per cent. of zinc, at 1750° F.

All these metals melt readily in the gas furnace. Quantities of 3 lbs. of copper or cast iron can be completely fused in fifteen minutes in a six-inch furnace. Quantities of 8 or 10 lbs. of copper or cast iron can be completely fused into a homogeneous mass in a six-inch or eight-inch furnace within one hour, using a sixteen-hole burner, and a supply of gas from a half-inch pipe.

In a furnace of the same size I have fused 45 ounces of nickel, and in other experiments I have produced masses of wrought iron weighing 18 ounces, 28 ounces, 40 ounces. The piece of 18 ounces was perfectly fused. The piece of 30 ounces was not quite fused, the crucible having melted, and stopped the operation. I have also fused cobalt, and reduced it to the metallic state from the peroxide by ignition with charcoal. The time required for the fusion of these refractory metals is from one and a half to two hours.

Scraps of platinum can be fused into a porous mass, but not into a solid homogeneous bead. I have mentioned that thin platinum wires fuse readily in the free flame of the gas-jet produced by the burner (Fig. 1); but when the jet plays upon a quantity of the metal contained in a crucible the relations of power and effect are different.

When the metals to be melted are such as do not undergo oxidation, the method of action represented by Fig. 2 is most convenient. In this manner gold can be readily melted, and by removing the gas-burner the melted metal can be stirred. When the action of oxygen is to be avoided, the crucible must have a cover, which in some cases should be securely luted to it.

Choice of Crucibles.—The experiments above referred to were made with coal gas at the ordinary pressure, and with a blast of cold atmospheric air. Greater effects can be produced by the use of oxygen gas, or of heated atmospheric air. But a difficulty stands in the way of the use of these greater degrees of heat in the want of crucibles capable of enduring their action.

With cold atmospheric air, pure nickel and pure iron dissolve every kind of siliceous crucible, and it is, therefore, needless to heat the air or to prepare oxygen till a superior kind of crucible is obtainable. At present, these metals can only be melted in plumbago crucibles, which necessarily communicate to them more or less carbon.

Metals which melt at moderate degrees of heat, such as gold and copper, are easily fused either in clay crucibles, or in those of plumbago; the latter, be it remembered, being a mixture of graphite and clay. Metals in combination with carbon, such as cast iron, also melt readily in clay crucibles, without destroying them. But when such metals as iron, nickel, and cobalt, are freed from carbon, and brought into a state of purity, they acquire an extraordinary attraction for silica at a white heat, so that the metal and the silica readily run down into a very fusible silicate. Even when plumbago crucibles are used, the carbon burns away at some particular point, the metal then attacks the clay, bores a hole through the crucible, and finishes the operation. No kind of clay or porcelain will withstand the action of pure iron or nickel at a white heat. It is therefore impossible to effect any large fusions of these metals when they are free from carbon, or when they are heated in crucibles that are free from carbon.

Fusion of Metals in large quantities, and Ignition of Objects of large size.—As the gas-burner, Fig. 1, can be held in any required position, it is possible to apply heat to large objects by using several gas-burners. Thus, a large crucible may be fixed in a square furnace, and gas-burners be applied below and on the four sides of the furnace; the spaces between the crucible and the walls of the furnace being filled with pebbles, to collect the heat and apply it to all parts of the crucible.

Muffle Furnace for Assaying, Roasting, &c.—A muffle, placed in an assay furnace, and built up with pebbles, can be heated either from above or from below by the blast gas-burner. The flame and products of combustion can be made to sweep through the muffle, whether going upwards or downwards. The *air* pipe and *gas* pipe attached to the gas-burner, Fig. 1, must each be provided with a stop-cock. When the front door of the muffle is opened to afford the opportunity for examining the cupels, the blast, if continued, would blow out there against the operator; but that occurrence is prevented by turning the stopcocks. When it is desired to oxidize the substances in the muffle, the furnace is first brought up to a sufficient temperature, and then the gas is turned off, but the blast of air is continued. The air passing through the hot pebbles enters the muffle at a high temperature, and not exhausted of oxygen, because there is no carbonaceous matter present among the pebbles when the gas is turned off. The pure and highly heated air is consequently in a proper condition for oxidizing metals that are already raised to a red heat in the muffle. The same apparatus is useful where substances require to be roasted in the presence of air, in order to oxidize and expel some volatile ingredient. We have in this process an effectual means of using hot air to aid the process of cupellation.

Distillation per Descensum.—Suppose a stoneware bottle with a long neck to be fitted with a stoneware tube, passing nearly to the bottom of the bottle, and projecting some inches beyond its mouth. Suppose this bottle to be half filled with metallic zinc, and then to be fixed upside down in the furnace, Fig. 2, with the tube projecting downwards through the hole in the plate *d*, and nearly dipping into a vessel of water. The furnace being packed with pebbles, and the heat applied at the top, the distillation of zinc *per descensum* then takes place.

Miscellaneous Uses of the Blast Gas Furnace.—1. The preparation of chemical substances by the projection of mixtures into a crucible kept at a red or a white heat. 2. For melting silver, gold, copper, cast iron, brass, bronze, nickel-silver, &c., either for making small castings or ingots. 3. For experiments on glass; every description of which it is able to fuse. 4. For experiments on enamel, colored glasses, and artificial gems. 5. For experiments on metallic alloys. 6. For the fusion of steel. 7. For the use of dentists, in the preparation of mineral artificial teeth. 8. For the assay of ores of silver, copper, lead, tin, iron, and other metals. 9. For all purposes of ignition, combustion, fusion, or dry distillation, at a red heat, or a white heat, where it is desirable to produce those temperatures promptly, certainly, steadily, conveniently, and cheaply.

Exhibition of Colored Flames.—When the gas-burner, Fig. 1, is supplied with gas and air, and is inflamed in the open air, so as to produce a clear blue flame of 3 inches long, and beyond it a flickering, nearly colorless flame of 12 inches long, brilliant colors may be given to this flame by the introduction of concentrated solutions of certain salts. A ball of pumice-stone, 2 inches in diameter, fastened to a stout iron wire, is dipped into the saline solution, and while wet is plunged into the flame, upon which the whole flame becomes colored. Solutions of the following salts may be used for these experiments:—

1. *Chloride of Strontium* gives a brilliant crimson flame. 2. *Chloride of Calcium*, a reddish orange flame. 3. *Chloride of Sodium*, brilliant yellow. 4. *Chloride of Copper*, blueish green. If the flame is touched on one side with the copper solution, and on the other with the strontium solution, half the flame is green and half crimson. The colors and reflections of these flames are necessarily most brilliant in a dark room. A remarkable effect is produced by the yellow soda flame. It is reflected from the human countenance with a ghastly blackness.

Repair of the Gas Furnace.—When the clay cylinders become warped or chipped, so as to allow the gases to escape at the joints laterally, they must be luted for each operation by applying a little wet fire-clay by means of a spatula. When only a moderate heat is required, this luting is unnecessary.

The Patent Blast Gas Furnace is capable of melting so many of the refractory metals, and in quantities that are so well adapted for the usual analytical experiments of chemists and assayers, as almost to supersed the use of fixed wind furnaces and portable blast furnaces, fed by charcoal or coke.

For the Journal of the Franklin Institute.

Notes on the Evaporative Efficiency of "Japanese Coals" for Steaming Purposes. By Wm. H. Shock, Chief Engineer U. S. Navy.

In obedience to an order of the late Commander-in-chief of the East India Squadron to furnish him with a statement of the comparative value of the Japanese coals for steaming purposes with that of other coals used in the Navy, I availed myself for this purpose of copies of the steam logs and engine diagrams of the frigates *Minnesota* and *Mississippi*, which were kindly furnished by their respective chief engineers, for the period in which they used the coals; and with the data in my own possession of the *Powhatan* whilst using the same coals, the following record of results was deduced:

It is proper to state that the coals were received on board the ships and expended in the usual manner, without any reference whatever to a special report. This fact establishes the *practical* value of the results.

Particulars of the Ships.—The *Minnesota* is a screw frigate 3200 tons. Two trunk engines, direct-acting. Working area of each piston, 4071·5 sq. ins. Stroke of pistons, 36 ins. Supplied by 4 multitubular boilers, Martin's patent. Heating surface, 11,500 sq. ft. Space displacement of piston for one revolution of one engine, 169·60 cubic feet. Space included in nozzles, clearance, &c., at both ends of one cylinder, 9·90 cubic feet. Total capacity for steam in one engine for one revolution, 179·50 cubic feet.

The *Mississippi* is a side-wheel steamer of the first class, 1692 tons. Two side-lever engines. Diameter of cylinder, 75·5 ins. Stroke of piston, 7 ft. Supplied with 2 multitubular boilers, Martin's patent. Heating surface, 7676 sq. feet. Space displacement of piston for one revolution of one engine, 435·20 cubic feet. Space included in nozzles, clearance, &c., at both ends of one cylinder, 21·52 cubic feet. Total capacity for steam in one engine for one revolution, 456·72 cub. ft.

The *Powhatan* is a side-wheel steamer of the first class, 2415 tons. Two inclined engines. Diameter of cylinder, 70 ins. Stroke of piston, 10 ft. Supplied with 4 copper boilers, double upper return flues. Heating surface, 8100·59 sq. ft. Space displacement of piston for one revolution of one engine, 534·50 cub. ft. Space included in nozzles, clearance, &c., at both ends of one cylinder, 26·00 cub. ft. Total capacity for steam in one engine for one revolution, 560·50 cub. ft.

Localities of the Mines and their mode of working them.—There are without doubt vast coal fields interspersed throughout the Japanese Empire, unknown even to the Japanese themselves. But of those known and worked, I have examined specimens from three, viz:—From one near Hakodadi on the island of Yesso, in the northern part of Japan; a second from Sikuzen on the island of Kiusiu (110 miles from Nagasaki); and the third from a mine in the province Satzuma, near Nagasaki: all presenting nearly the same characteristics.

I have never been permitted at any time to visit the mines. They persistently objected to foreigners inspecting them; but from the most reliable authority I learned that they are worked without the aid of machinery, both coal and water being brought out on the backs of coolies in buckets; and the working of an opening is quickly suspended when the labor necessary to keep down the water exceeds that required to bring away the coals, which soon occurs after getting below the surface, particularly in a country abounding in springs, as does Japan. The result is that old openings are abandoned before they are worked sufficiently deep to secure good coals, and hence it rarely if ever occurs that any but outcroppings and surface coals reach market.

Description of the Coals.—Their Furnace Phenomena.—The coals are bituminous. Cohesion weak. Mechanical structure, lamellar. Fractures exhibit a dull black in all their partings. 37 cub. ft. displace one ton. In the furnace it kindles easily and burns freely with a bright flame, emitting immense volumes of densely black smoke. Intumesces slightly, and occasionally I found traces of iron pyrites present in minute quantities.

Residuum—Large quantities of spongy clinker (from 27 to 30 per cent. by weight) which cake on the bars but are readily removed. The per centum of clinker by *weight* conveys no idea of its *bulk*, as it must have reached in many cases the enormous proportion of 50 per cent.! The proportion of ashes produced was unusually small.

Data and Results deduced therefrom.

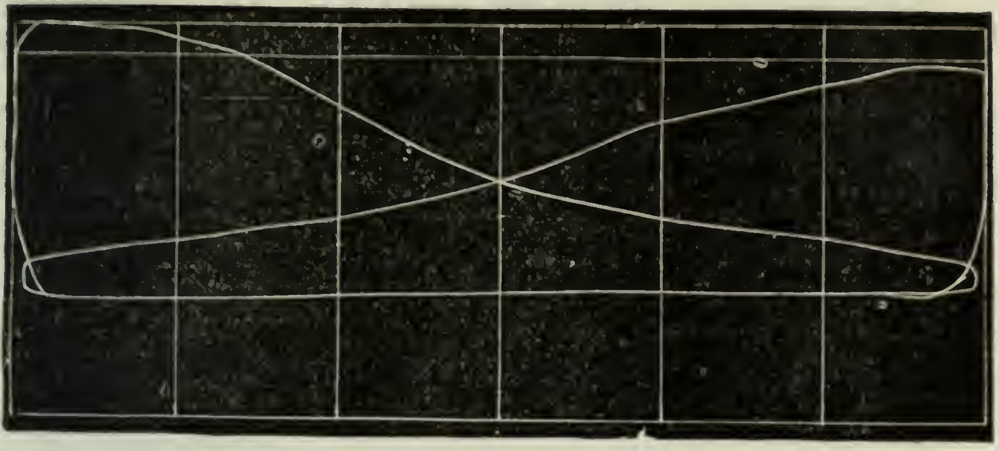
Copy MINNESOTA'S *Steam Log.* CAPT. S. F. DUPONT *Commanding. At sea, September 1st,* 1858.

Hour, A.M.	Speed.		Course.	Wind.		Revolution of Engine.	Pressure of Steam.	Vacuum.		Throttle.	Coal	Ashes.	Sat. of Boilers.				Temperature			Mean Terminal Pressure of the Day's Diagrams. 6·718 lbs.
	K.	F.		Direc.	Force.			A.	F.				1	2	3	4	Engine Room.	Hot-well. A.	F.	
1	7	4	W S W.	SE by S.	4	33·1	7	19	23	¾	3640		1½	2	1½	1¾	106	104	104	
2	7	4	"	S.	4	31·6	5	19	22	¾	4200		1½	1¾	1⅝	1¾	104	102	102	
3	9	4	W by S.	"	4	35·1	8	19	22	¾	5740		1½	1¾	1⅝	1½	104	102	102	
4	10	4	"	"	5	36·5	12	20	22	¾	6440	13520	1¾	1⅝	1⅝	1⅝	104	104	104	
5	8	4	W S W.	S. by E.	5	26·5	12	19	21	⅝	2520		1¾	1⅝	1½	1½	106	98	97	
6	7	4	W by S.	"	5	29·8	8	19½	22	1	4760		1¾	1⅝	1¾	1⅝	106	98	97	
7	7	4	"	"	4	31·6	10	20	22	⅞	2240		1¾	1¾	1¾	1¾	106	98	97	
8	7	2	"	S S E.	4	33·7	11	20½	22	¾	6020	9048	1	1⅝	1¾	1¾	106	100	100	
9	8	2	"	"	4	33·6	9	19½	22	¾	3080		1¾	1¾	1⅝	1¾	106	98	98	
10	7	4	"	"	3	32·1	7	19½	22	¾	2800		1¾	1¾	1⅝	1¾	101	97	97	
11	7	2	"	"	3	31·	6	19½	22	¾	3920		1¾	1¾	1¾	1¾	101	97	97	
12	7	6	"	E.	4	39·5	10	19½	22	¾	7000	10408	1¾	1⅝	1¾	1¾	101	97	97	
Expended, 105,000 Japan Coals.						Revolutions made, 48,865.							Knots run, 189·4							
P.M.																				
1	10	4	W ½ S.	N E.	4	39·	10	25½	24	¾	3640		1¾	1⅞	1¾	1¾	101	98	99	
2	11	6	"	N.	5	39·	10	23	23	¾	3220		1⅞	1¼	1¾	1¾	102	96	98	
3	5–4	6	W by S.	N by W.	6	40·	13	25½	23	⅝	7980		1¾	1¾	1⅝	1⅝	102	98	100	
4	4–6		"	"	10	33·	9	25½	23	⅝	4900	5750	1½	1½	1½	1½	102	98	100	
5	7	4	"	"	9	33·1	10	23½	22½	⅝	4060		1¾	1⅝	1¾	1¾	105	98	101	
6	7	4	W.	"	8	29·3	8	24	22½	⅝	3360		1½	1½	1¾	1⅝	105	98	101	
7	6	4	"	"	6	33·9	12	24	23	⅝	4620		1⅝	1¾	1⅞	1½	98	95	95	
8	6	4	"	"	6	33·3	10	24½	23	⅞	7000	13312	1½	1½	1¾	1⅝	98	95	97	
9	5	4	"	"	7	31·5	9	24½	23	⅞	3500		1½	1½	1¾	1⅝	94	94	95	
10	5	4	"	"	7	28·8	7	24	23½	1	3500		1½	1½	1¾	1⅝	94	95	95	
11	5	4	"	N N W.	7	34·6	8	24	22½	⅞	3360		1½	1⅝	1¾	1⅝	94	95	95	
12	6	4	W ½ S.	"	8	34·6	8	24	22½	⅞	3500	11232	1½	1⅝	1¾	1⅝	94	95	95	

U. S. S. F. MINNESOTA, Sept. 1st, 1858, 11·10 A. M.

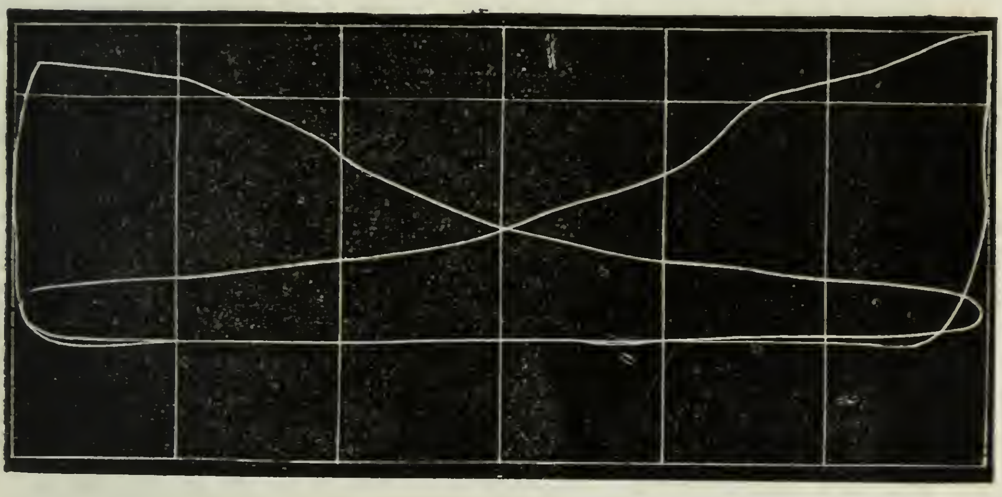
Scale, 1-10th inch = 1 lb.

Steam,	10	Hot-well,	98°
Vacuum,	22½	Throttle,	¾
Revolutions,	34		



U. S. S. F. MINNESOTA, Sept. 1st, 1858.

Steam,	10	Hot-well,	97°
Vacuum,	23	Throttle,	¾
Revolutions,	34		



From the above log and diagrams we get the following data.—

Mean terminal pressure of the four diagrams, .	6·718 lbs.
Average coal per hour, . . .	4375 "
" revolutions per minute, . . .	33 9
" temperature of feed-water, . .	139°
" saturation of boilers, . . .	11-16
" throttle, ...	¾

From which the following calculation of boiler performance while using Japan coals is made, viz.:

$$\frac{179{\cdot}50 \times 33{\cdot}9 \times 2}{3538} = 3{\cdot}439.$$

And

$$\frac{3{\cdot}439 \times 60 \times 64{\cdot}3}{4375} = 3{\cdot}03 \text{ lbs. water.}$$

To this must be added the per centum of useful effect lost in fuel from blowing to maintain the boiler water at a saturation of $\frac{1\frac{1}{6}}{32}$ which in this case was found to be 12, its equivalent in pounds of water evaporated being ·3636. And 3·03 + ·3636 = 3·39 lbs. of water evaporated per pound of coal, was the maximum boiler performance with Japan coals.

By examining the above log, it will be seen that the ashes and clinker for the 24 hours, exceeded the enormous figure of 60 per centum.

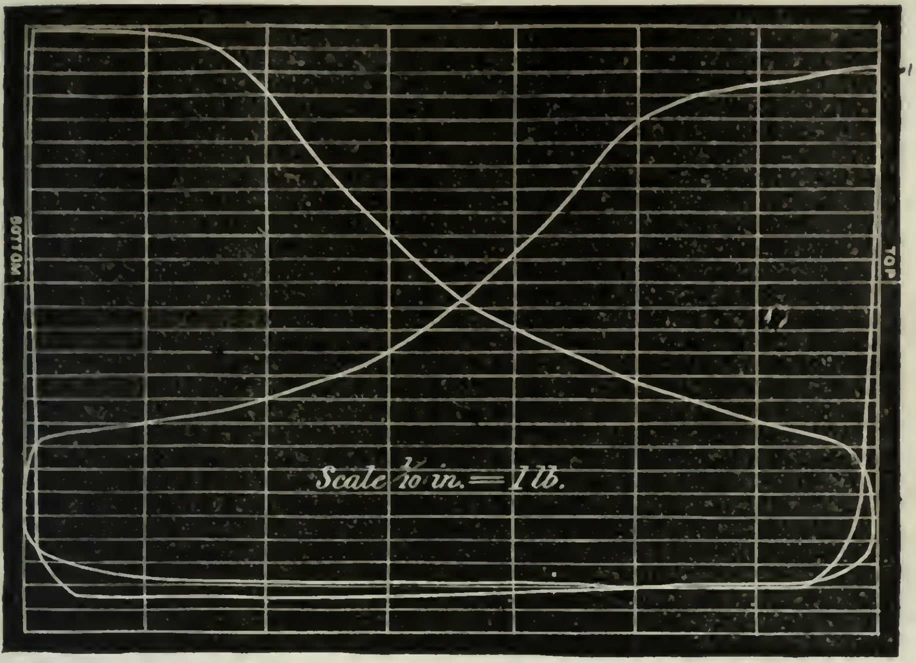
Remarks.—Large deposits of soot and ashes collecting on lower tube sheets and around the tubes.

Copy Steam Log of the U. S. Steamer MISSISSIPPI. CAPT. WM. C. NICHOLSON, *Commanding. At sea, August 4th,* 1858.

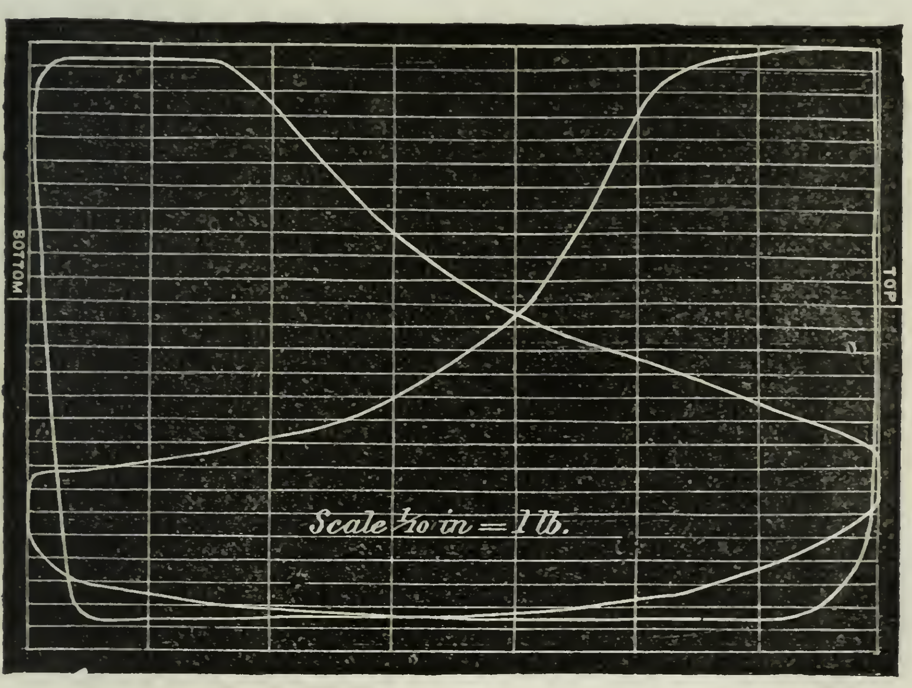
H. A. M.	Speed.		Course.	Wind.		Revolution of Engine.	Ashes, lbs.	Pressure of Steam.	Vacuum.		Throttle.	Coal lbs.	Saturat. of boilers		Temperatures					Mean Terminal Pressure of the Day's Diagrams,
	K.	F.		Direc.	Force.				S.	P.			1	2	Hotwell.	Feedw'r.	Engine Room.	On deck.	Inject. water.	
1	8		N b E½E	S W.	2	8·6		7	27·5	27	2	2640	1¾	1¾			96			8·31 lbs.
2	8	4	“	W.	3	10·1		11	“	“	“	2970	“	“			97	70	72	
3	8	4	“	“	3	10·1		11	“	“	“	2970	“	“			97			
4	8	4	“	N W.	2	9·6	4400	11	“	“	“	2860	“	“	96	130	97	70	72	
5	7	6	“	“	1	8·8		8	“	“	“	2970	“	“			90			
6	8		N ½ E.	N.	1	9·		9	“	“	“	2970	“	“			80	70	72	
7	7	4	“	N by E.	2	8·8		9	“	“	“	2970	“	“			90			
8	7	4	“	“	2	9·1	4200	10	“	“	“	2970	“	“	98	133	92	70	72	
9	6	6	“	N N E.	2	8·5		8	“	“	“	2970	“	“			88			
10	7		“	“	2	8·5		8	“	“	“	2860	“	“			88	73	72	
11	7		“	“	2	9·1		10	“	“	“	2860	“	“			90			
12	7		“	“	2	9·1		10	“	“	“	2860	“	“	100	135	88	75	72	
Expended, 69,905 Japan coals. Revolutions made, 13,310. Knots run, 186·4 per log.																				
P.M.																				
1	3	4	N ½ E.																	
	4	2	N by W.	N by E.	2	9·1		10	27·5	27	2	2860	1¾	1¾			90			
2	8		“	N N W.	2	9·3		10	“	“	“	2860	“	“			93	78	73	
3	8		“	“	2	9·8		11	“	“	“	2970	“	“			94			
4	5	2	“																	
	2		N.	“	2	8·8	3750	9	“	“	“	2970	“	“	98	130	90	78	73	
5	8		“	“	2	9·3		11	“	“	“	2970	“	“			90			
6	4		“																	
	4		N by E.	“	2	10·1		13	“	“	“	2970	“	“			90	77	73	
7	8		“	N.	1	10		11	“	“	“	2970	1⅝	“			91			
8	8	2	“	N N E.	1	10	4900	11	“	“	“	2970	“	“	106	142	90	78	73	
9	7	6	N E ½ E.	N by E.	1	8·6		8	“	“	“	2860	“	“			90			
10	7	4	“	N N E.	2	8·8		9	“	“	“	2860	1¾	“			90	75	73	
11	8		“	“	2	8·8		9	“	“	“	2915	“	“			90			
12	8		“	“	2	9	4150	10	“	“	“	2860	“	“	92	130	87	74	73	

PORT ENGINE.

U. S. S. F. Mississippi, Aug. 4th, 1858.



Average steam per gauge,	10 lbs.	Vacuum, . .	26·75
Revolutions, . .	8·55	Throttle, .	2
Lift of steam-valve,	3 ins.		



Average steam per gauge,	10·25 lbs.	Vacuum, . .	27·5
Revolutions, . .	9	Throttle, .	2
Lift of steam-valve, .	3 ins.		

From the above log and diagrams the following calculations of boiler performance while using Japan coals are made, viz :—

Mean terminal pressure of the diagrams,	8·31 lbs.
Average coal per hour,	2912 "
" revolutions per minute,	9·24
" temperature of feed-water,	135°
" saturation of boilers,	1·75
" throttle,	2
" steam per gauge,	9·7 "

$$\frac{456{\cdot}72 \times 9{\cdot}24 \times 2}{2829} = 2{\cdot}983.$$

And $$\frac{2{\cdot}983 \times 60 \times 64{\cdot}3}{2912} = 3{\cdot}95 \text{ lbs. of water.}$$

To this (as in the case of the *Minnesota*) an additional per centum for loss of useful effect in fuel from blowing to maintain the boiler water at a saturation of $\frac{1\frac{3}{4}}{32}$ must be added, which is found to be 11·6, its equivalent in pounds of water evaporated being ·458; and ·458+3·95=4·408 ℔s. of water evaporated per pound of coal, was the maximum boiler performance.

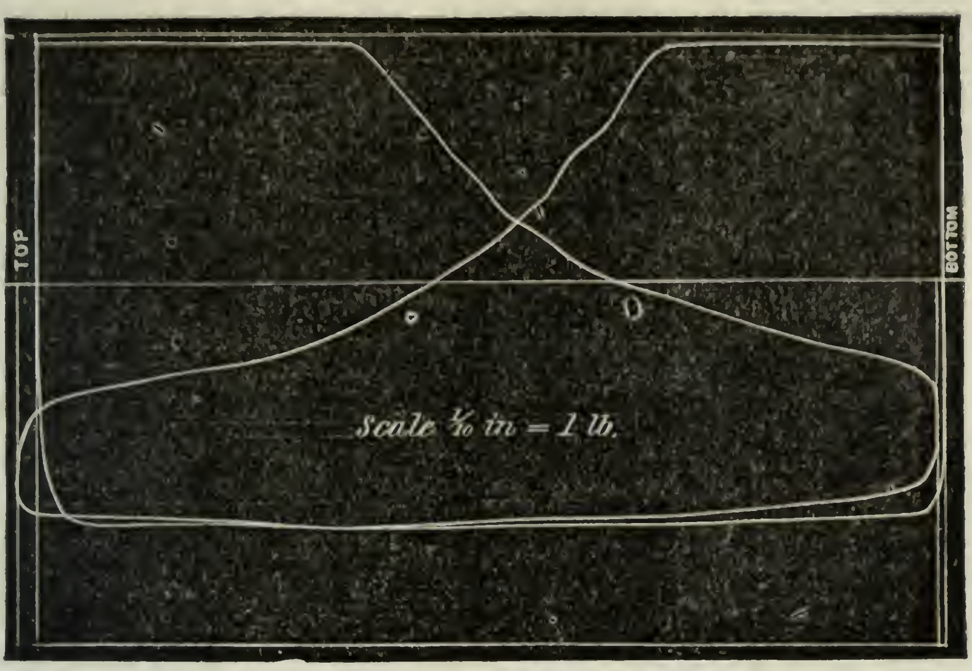
The residuum in clinker and ashes for this day was 36·75 per cent.

Remarks.—Immense quantities of soot and cinders collecting on the tube sheets and between tubes, rendering it necessary on one occasion to clean them while under way.

Copy Steam Log of the U. S. Steamer POWHATAN, *Flag Ship of Flag Officer Tattnall.*
CAPT. G. F. PEARSON, *Commanding. At sea, July 23d,* 1858.

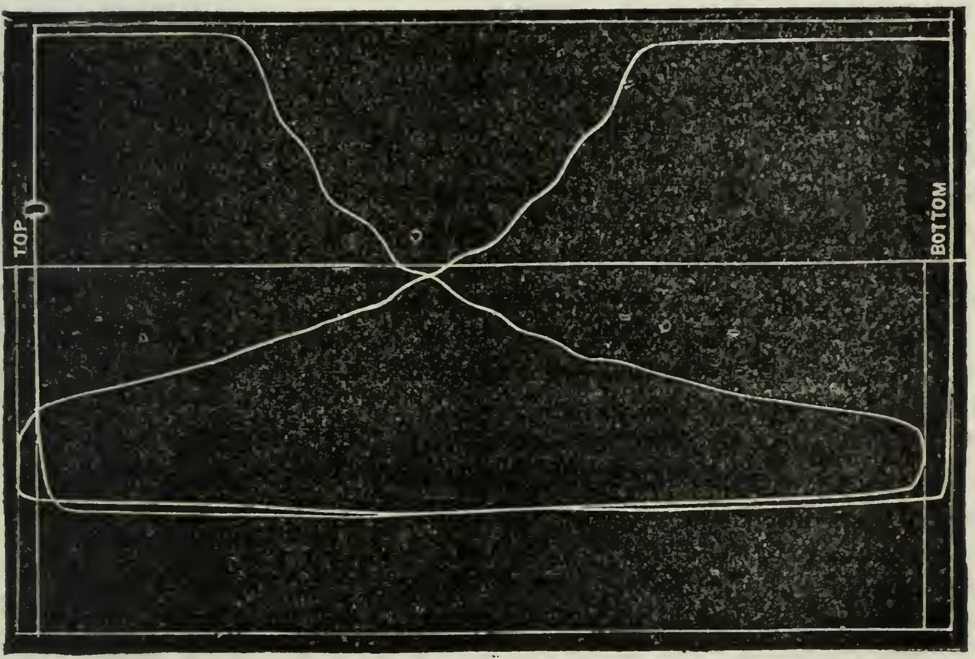
H. A. M.	Speed.		Course.	Wind.		Revolutions of Engine.	Hot-well.	Pressure of Steam.	Vacuum.		Throttle.	Coal lbs.	Sat. of Boilers.				Temp.		Ashes, lbs.	
	K.	F.		Direc.	Force.				S.	P.			1	2	3	4	Engine Room.	On deck.		
1	9		SbW¾W.	S by W.	3	9·7	120	10·5	25¼	25¼	8	4367	1⅝	1¾	1⅝	1⅝	106	80		42·9 ins. aver. point cutting off from com'ment of stroke, includ. clearance, &c.
2	8		"	"	3	9·5	120	10	"	"	"	4291	1¾	"	1¾	"	106	81		
3	7		"																	
		4	SbyE½E.	S S W.	3	8·9	115	9·5	"	"	"	4015	"	"	"	"	105	80½		
4	5		"	"	3	8·6	116	9·5	"	"	"	3285	"	"	"	1¾	97	80	3240	
5	5		"	SW by S.	4	9·1	116	10	25½	25½	"	3285	"	"	"	"	88	80		
6	5		"																	
	2	4	E S E.	"	4	10·7	119	10·5	"	"	"	4974	"	"	"	"	89	80½		
7	4	4	SEbE½E.																	
	4	4	E S E.	"	4	11·1	"	10·5	"	"	"	4974	"	"	"	"	88	78		
8	9	4	"	"	4	11·6	"	10	"	"	"	5840	"	"	"	"	92	80	4800	
9	9		"	"	4	11·5	"	10	"	"	"	5840	"	1⅝	1⅝	"	90	79		
10	9		"	S W.	4	11·3	"	10·5	"	"	"	4974	"	1¾	1¾	"	93	79		
11	9		"	"	4	11·8	120	10·5	"	"	"	4526	1⅝	1⅝	"	"	94	81		
12	9		E ¼ S.	"	3	11·5	120	10·5	"	"	"	4774	1⅝	1⅝	"	"	96	84	4200	
Expended, 100,886 Japan coals. Revolutions made, 15,958. Knots run, 209·4.																				
P.M.																				
1	9	4	E N E.	S W.	3	11·5	120	10·5	25½	25½	8	4818	1¾	1¾	1¾	1⅝	94	82½		
2	10		NEbE½E	"	3	12·4	"	10	"	"	"	4774	"	"	"	1⅝	91	81½		
3	9	4	"	S S W.	3	11·5	"	9·5	"	"	"	3870	"	"	"	1¾	89	80		
4	9	4	"	"	3	11·5	"	9·5	"	"	"	3504	"	"	"	"	88	78	3360	
5	9		"	"	3	11·5	118	9·5	"	"	"	3792	"	"	"	"	87	78		
6	9	4	"	"	3	11·4	120	9·5	"	"	"	4233	"	"	"	"	90	78		
7	9	4	"	SWbyW.	5	11·4	"	9·5	"	"	"	3870	"	"	"	"	90	79		
8	9	4	"	"	5	11·6	"	10	"	"	"	2430	"	"	"	"	90	79	4620	
9	10		"	"	6	11·6	"	9·5	"	"	"	4453	"	1⅝	"	1⅝	92	80		
10	10		"	"	6	11·8	"	9·5	"	"	"	3577	"	"	"	"	91	80		
11	10		"	"	6	11·6	"	9·5	"	"	"	3500	1⅝	"	1⅝	"	91	80		
12	11		"	"	6	11·8	"	9·5	"	"	"	2920	1¾	"	1⅝	"	91	80	2580	

U. S. S. F. Powhatan, July 23d, 1858.



Steam,	10·5	Revolutions,	11·4
Vacuum,	25·5	Throttle,	8
Hot-well,	118		

PORT ENGINE.



The following data deduced from the above log is the basis of the calculation for the boiler's performance with the Japan coals.

It will be observed that the terminal pressure of the diagrams is not taken, as in the case of the other ships. That course of procedure was rejected in consequence of the frequent changes of the cut-off during that 24 hours, on account of the variableness of the wind, sea, &c. And although the results from the two modes of calculation will not vary much, yet I thought that taking the average point of cutting off as shown by the log would give a more correct result, and hence their adoption.

Average pressure of steam per gauge, . .	9·9 lbs.
" revolutions per hour, . . .	664·9
" consumption of coal per hour, . .	4203 "
" point of cutting off, from commencement of stroke, including clearance, &c., &c., .	42·9 ins.

From which we gather the following results :—

$$\frac{3848{\cdot}4 \times 42{\cdot}9 \times 2 \times 11{\cdot}08 \times 2}{1728} = 4234{\cdot}4$$

And $$\frac{4234\ 4}{1064} = 3{\cdot}97 \text{ lbs. water.}$$

The loss from blowing to maintain the boiler water at its nominal density, viz: 1·75, was 12·9 per cent., its equivalent being ·510; and 3·97 + ·510 = 4·7 lbs. of water evaporated to one pound of coal.

Residuum in clinker and ashes, 22·5 per cent.

The English government have recently despatched a steamer (the *Roebuck*) to Japan, for the express purpose of practically testing these coals; the results of which will be looked for with much interest.

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*The Magnesian Light.**

Magnesium is well known as the metallic basis of magnesia; it is much lighter than aluminum, as its specific gravity is only 1·74; it is of a silvery whiteness, undergoes no change in dry air, and is subject to but slow oxidation in a damp atmosphere, and that only quite supercially; it may be hammered, filed, and drawn into threads. At the beginning of the present century its properties were developed by Davy, and still more thoroughly by Busse. To obtain it pure is an expensive process; and as no practical advantage could hitherto be made of it, no one had attempted to discover a cheaper method of getting it. It was reserved to Bunsen to perceive a new property in this metal, and to suggest a practical application of it. Magnesium takes fire at the temperature at which glass melts, and burns with a steady and extremely vivid flame. In some photo-chemical investigations by Bunsen and Roscoe, experiments were made to test the illuminating capacity of a magnesium thread, when Bunsen discovered that the splendor of the sun's disc was only 524 times as great as that of the thread. Bunsen also compared the magnesium flame with ordinary lights, and found that a burning thread of 0·297 millimetres diameter, produces as much light as 74 stearine candles, of which five go to the pound. It is plain that it only needs a mechanical device to spin magnesium when heated into the form of a thread upon spools, from

* From the Lond. Chemical News, No. 27.

which they can be run off like the strips of paper in Morse's telegraphic apparatus, to render it of practical use. Such a magnesium lamp-wick would be far more simple and complete than the preparations for the use of the electric or the Drummond light. A spool with its thread, a clock-work to wind it off, with the spirit lamp, would be easily transportable. A rival, therefore, to the strong lights hitherto used is like to spring up in Bunsen's magnesium-lamp, in all those cases where the item of expense is likely to be slightly regarded, for example, in brilliant illuminations, light-houses, &c., for extraordinary degrees of illumination may be obtained by burning several of these threads of large dimensions at once.—*Engineer.*

On the Influence of Science on the Art of Calico Printing.[*]

By Professor F. Crace Calvert, F.R.S.

Calico printing has partaken of the general progress of the manufacturing arts; and this can be easily understood when it is remembered that it is based upon three distinct branches of knowledge—mechanics, art, and chemistry. Not being acquainted with machinery, I shall not attempt to describe the various mechanical improvements and machines which have been introduced; but shall confine myself to stating that ever since 1815, the period at which it was first extensively applied in the print works of Lancashire, machinery has gradually supplanted hand labor, and thereby immensely decreased the cost of production, at the same time that it has improved the beauty and precision of the results obtained.

Penciling and Block-Printing.—During the early part of this century, the production of designs upon calico was performed by means of hand-blocks, made of sycamore or pear-tree wood, 2 ins. or 3 ins. thick, 9 ins. or 10 ins. long, and about 9 ins. broad. The face of the block was either carved in relief into the desired pattern, like ordinary wood-cuts; or the figure was formed by the insertion edgewise into the wood of narrow slips of flattened copper wire, and the patterns were finished by the hand labor of women with small brushes, called pencilings. Owing to a strike amongst the block printers, in 1815, to resist the threatened introduction of machinery, great efforts were made on the part of the employers to render themselves independent of hand labor; and the result has been the gradual introduction of cylinder-printing. Without entering into the intricate details of the steps by which the art of engraving has been carried to its present high degree of perfection, I shall simply give an outline of the successive improvements alluded to.

Engraving.—The first kind of roller used was made by bending a sheet of copper into a cylinder, soldering the joint with silver, and then engraving upon the continuous surface thus obtained.

The second improvement consisted in producing the pattern on copper cylinders obtained by casting, boring, drawing, and hammering. In this case, the pattern is first engraved in intaglio upon a roller of softened steel of the necessary dimensions. This roller is then hardened and introduced into a press of peculiar construction, where, by rotary pressure, it transfers its design to a similar roller in the soft state, and the die being in intaglio, the latter, called the "mill," is in relief. This is hardened in its turn, and by proper machinery is made to convey its pattern to the full-sized copper roller. This improvement alone reduced the cost of engraving on copper rollers many hundreds per cent.; and, which is of far greater importance, made practicable an infinite number of intricate engravings which could never have been produced by hand labor applied directly to the roller.

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[*] From the London Engineer, No. 220.

A further improvement was made by tracing with a diamond on the copper roller, covered with varnish, the most complicated patterns by means of eccentrics, and then etching.

The combination of mill engraving with the tracing and etching processes naturally followed, adding immensely to the resources of the engraver and printer in the production of novel designs.

Another development of this art is the tracing of patterns on the surface of rollers, which has been effected by machines constructed on the principle of the pentagraph. Although this invention dates from 1834, still it is only of late years that it has been successfully applied.

But if mechanical art has greatly assisted the engraver, chemistry has rendered him equally important services, by enabling him to abandon costly and cumbrous modes of impressing by force the designs on the cylinder, substituting for them a great number of etching processes. By some of these processes, as by every other addition to the resources of the engraver, an entirely new and beautiful class of engraving is produced, unattainable by any other known means.

A very recent improvement is highly interesting in a scientific point of view. It is the application of galvanism to the diamond tracer. By combining the galvanic action with the eccentric motion, most beautiful and delicate engravings can be produced. This is effected by tracing the pattern with a varnish on a zinc cylinder, which is so placed in the engraving machine, that as a needle passes over its surface, and comes in contact with the zinc, the galvanic current is established, and, by simple machinery, causes the diamond to trace the corresponding pattern on the copper roller. The communication is so rapid and so precise, that this invention of Mr. Gaiffe, of Paris, bids fair to produce very important results. Galvanism is also made use of, for producing effects on roller surfaces by depositing copper thereon.

To give an idea of the extraordinary influence which the introduction of machinery and improvements in engraving have had in cheapening the cost of printed calicoes, I may state that large furniture patterns, such as are required for Turkish, Egyptian, and Persian markets, into which sixteen colors and shades enter, would have cost formerly from 30s. to 35s. per piece, because they would have required sixteen distinct applications of as many different blocks, and would have occupied more than a week in printing, where the same piece can now be printed in one single operation, which takes three minutes, and costs 5s. or 6s. So rapid is the progress of one branch of manufacture in connexion with another, that it has only recently been possible to produce the rollers capable of performing this operation, that is to say, cylinders of copper 43 ins. in circumference by 44 ins. long. For light styles of printing, the time required to print a piece of 36 yards is not more than one minute.

Chemistry.—But the discovery which has exercised more influence than any other on the progress of calico printing, is the application of chlorine gas as a bleaching agent. Previously to the employment of this gas (chiefly as bleaching powder), the imperfect bleaching of a piece of calico required six weeks; and as it had to be exposed to the action of the atmosphere, a large surface of land was required. Further, at that time, bleachers had to use potashes imported from Canada; whereas, at the present time, thanks to the progress of chemical knowledge, not only is soda-ash manufactured in this country, but, by the application of bleaching powder, calicoes are much better bleached in twenty-four hours than they were formerly by a six weeks' exposure to the atmosphere; and even when an extra cleaning and whiteness is required, as for madder goods, only two days are necessary. The aid of machinery renders possible the continuous process, that is to say, several hundred pieces of grey calico are sewn together, end to end, and made to pass from one operation to another, without any pause, until they are bleached. So rapid and economical is this method that the cost of bleaching a piece of calico does not exceed one or two pence. Chlorine, again, renders a great service to the calico printer, by enabling him, after his madder goods have been produced and soaped, to obtain fine whites without the necessity of exposing them for several days in the meadows to the action of the atmosphere. In fact, the discovery of garancine and alizarine, and their application to calico printing, have facilitated the production of madder styles at very low cost, as the whites of such goods require no soaping, and only a little bleaching or cleaning powder.

Cotton has this peculiarity as distinguished from wool and silk, that it will not fix any organic color, excepting indigo, without the interposition of a mordant, which is generally a metallic oxide or salt. The two most important discoveries in connexion with this necessity of calico printing were: first, that made in 1820, by Mr. George Wood, of Bankbridge, who found out the means of preparing calicoes with peroxide of tin, which enabled printers to produce a large variety of prints called steam goods; and, secondly, that of Walter Crum, Esq., F. R. S., who, in a paper presented to the British Association, at Aberdeen, in 1859, showed that the tedious process of ageing madder mordants for three or four days, might be dispensed with by passing the goods during a quarter of an hour through a moist atmosphere, at a temperature of 80° to 100°, where the mordants absorb the required quantity of moisture, and then rapidly undergo the chemical changes necessary to fit them for producing the black, purple, lilac, red, pink, and chocolate colors, which the madder root will yield immediately in the dyebeck, according to the nature of the mordant previously fixed in the cloth.

As it is impossible in the brief space of an hour to convey an idea how various colors are produced on prints, I shall confine my remarks to illustrating the interesting fact that abstruse science has brought to light various substances, which have lately proved valuable accessories to the resources of the calico printer. Thus Dr. Prout, some thirty or forty years ago, made the curious discovery that uric acid possessed the property of giving a beautiful red color, when heated with nitric acid, and then brought into contact with ammonia The substance thus obtained was further examined by Messrs. Liebig and Wöhler, in a series of researches which have been considered as amongst the most important ever made in organic chemistry; and this substance they called murexide. In the course of these investigations, they also discovered a white crystalline substance called alloxan. For twenty years both these substances were only to be found in the laboratory; but in 1851, Dr. Saac observed that alloxan, when in contact with the hand, tinged it red. This led him to infer that alloxan might be employed to dye woolens red; and further experiments convinced him that if woolen cloths were prepared with peroxide of tin, passed through a solution of alloxan, and then submitted to a gentle heat, a most beautiful and delicate pink color resulted. Subsequently, murexide was employed and applied successfully by Mr. Depouilly, of Paris, to dyeing wool and silk, and to printing calicoes, by the aid of oxide of lead and chloride of mercury as mordants; but the great obstacle to its extensive use was the difficulty of obtaining uric acid in sufficient quantity for its manufacture. The idea soon occurred to chemists to extract it from guano; and this is the curious source whence the chief supply of uric acid is obtained, and which enables Edmund Potter, Esq., and other printers, to produce the color called Tyrian purple.

Another example will be found in the successive scientific discoveries which have led to the discovery of the recently popular color, mauve. Lichens, which have been the subject of extensive researches on the part of Robiquet, Heeren, Sir Robert Kane, Dr. Schunck, and especially of Dr. Stenhouse, have yielded to those chemists several new and colorless organic substances, which, under the influence of air and ammonia, give rise to most brilliant colors, and amongst these are orchil and litmus. Dr. Stenhouse, in a most elaborate paper published by the Royal Society in 1848, pointed out two important facts: first, that the color-giving acids could be easily extracted from the weed by macerating it in lime water, from which the coloring matters were easily separated by means of an acid; and, secondly, the properties of certain coloring acids, which gave M. Marnas, of Lyons, the key which enabled him to produce commercially from lichens, a fast mauve and purple which up to 1857 had been considered impossible of attainment.

The commercial production by Mr. W. H. Perkin of another purple at the same time is not less interesting. Some thirty or forty years ago, Dr. Runge obtained from coal-tar six substances, amongst which was one called kyanol, which substance was thoroughly examined by

Dr. W. A. Hofmann, who proved it to be an organic alkaloid, and identical with a substance known by the name of aniline. Owing to the subsequent study of this substance by that eminent chemist, and the discovery that it yielded a beautiful purple color when placed in contact with bleaching powder, his pupil, Mr. W. H. Perkin, was induced to make experiments with a view to producing commercially a fast purple, in which he succeeded, and secured it by a patent in 1857. The process devised by this chemist is exceedingly simple. It consists in oxidizing aniline by means of bichromate of potash and sulphuric acid. I shall not attempt to give any further details on this subject, as they have been very ably described by Mr. Robert Hunt in the *Art Journal.*

More recently, Mr. Renard found a method of producing also from aniline by means of chlorine compounds a most splendid rose color, called by him fuchsiacine; and within the last few months, Mr. David Price has also succeeded in producing from aniline, by the employment of peroxide of lead, either a fast purple or a pink, called by him roseine, and a fast blue according to the mode of operating. All these colors require special mordants to fix them on calicoes or muslins; and the beautiful specimens which I have the honor to lay before you I owe to the kindness of Messrs. James Black and Co., and Messrs. Boyd and Hamel of Glasgow, who have fixed the last-mentioned colors by means of azotized principles, such as albumen, lactarine. &c.,

I cannot give a better idea of the immense magnitude of the calico-printing trade than by quoting the number of yards exported, which amounted in 1858 to 785,666,473, and give a price value of £13,-147,280.

I cannot conclude without expressing also my thanks to Mr. Wood, of the firm of Wood and Wright, and Mr. R. Leake, of the firm of Lockett, Sons, and Leake, Messrs. Dalglish and Faulkners, for the numerous and valuable specimens which they have kindly lent me to illustrate my discourse; and especially to Mr. W. Grant for the loan of a most interesting book, containing the patterns belonging to the late firm of Sir Robert Peel, Bart., which bears the date of 1790.

Persistent Activity of Light.

We take the following interesting facts on this subject from the *Cosmos*:—"Some weeks ago, M. Niepce de Saint-Victor came to see us, bringing with him a large tin tube, closed not with sealing-wax but hermetically, and rendered inaccessible to all external agencies except variations of temperature, by a complete soldering with tin or lead. He opened the tube in our presence, exposed, without unrolling it, a sheet of paper prepared with tartaric acid and insolated, which he had inclosed in the tube nearly a year before, poured on this sheet a few drops of nitrate of silver, and showed us that the nitrate was almost immediately blackened, exactly as it would have been in a strong light. It was impossible not to attribute this instantaneous action to the persistent action of the light absorbed a year ago by the paper soaked in tartaric acid. If the experiment was more successful this time, although kept for a longer period, it was because of the much more perfect closure of the tube; and that which happened after a year would certainly happen after five or six years."

"Again, M. Busk has established the following fact: Plunge a sheet of paper into a solution of a properly chosen acid, organic or inorganic, for example, acetic or tartaric acid; dry it; render it sensitive by the bath of nitrate of silver, and dry it again; place it in contact with the drawing which it is desired to reproduce for a half hour or more; then expose the paper to the sun's rays, and a negative image of the drawing will be seen, which may be fixed by washing with common water. It is not even necessary that the exposure to the light should take place at once; the paper may be preserved for several days between two sheets of white paper without losing its property of developing the latent image under the influence of the sun's rays. What is more difficult to explain is that there is no necessity of insolating or exposing to light the original picture. M. Busk usually employs the following formula:—*Solution of organic acid:* water, 90 grammes; crystallizable acetic acid, 30; dip the sheet simply in it. *Bath:* water, 25 grammes; nitrate of silver, 3·60 grammes; crystallizable acetic acid, 3·5 grammes; the sheet may either be laid on the bath successively on its two sides, or be washed on each face by a brush."

"To these facts, or to their interpretation, M. Baron Thenard would oppose the following experiment which he has communicated to the *Philomathic Society.*—1st. During the night he *disinsolated* a sheet of common paper by exposing it to the vapor of water for an hour. 2d. He then divided the paper into two parts; one was laid aside for comparison, the other was rolled up and placed in a glass tube, to one end of which ozonized oxygen was supplied; at the end of a quarter of an hour the ozone was distinctly perceived at the other extremity; the paper was then withdrawn. 3d. This paper used in the same manner as M. Niepce's insolated paper produced the same effects; the paper kept for comparison produced none of them. 4th. A paper treated with chlorine or nitrate of silver and then ozonized gave, on the contrary, no sensible result. 5th. Common paper ozonized and kept for some time in a test tube disengages a smell which is not that of ozone but that of a very diffusible essence. What shall we conclude from this? added M. Thenard—That the phenomena of insolation described by M. Niepce are chemical phenomena, determined indirectly by the light, which acts in this matter only as an intermediate agent."

Manufacture of Stearine Candles.

At the meeting of the French Academy of Sciences of 18th June, 1860, M. Dumas presented a note from M. Cambacérès, who has studied thoroughly and for a long time the interesting question of the saponification of the fat-acids, their solidification, and transformation into stearine candles. He has discovered that by substituting dilute nitric acid for the concentrated acid usually employed, and assisting the action by a long contact under the influence of heat, the quantity of the fatty matter which solidifies is considerably increased, and a very great economy introduced into the manufacture.

On the Thermodynamic Theory of Steam Engines with dry Saturated Steam, and its application to practice. By W. J. MACQUORN RANKINE, C. E., F. R. S., &c.*

Phil. Trans. 1859, p. 177; and Phil. Mag. S. 4. vol. xviii. p. 71.

This supplement gives the dimensions, tonnage, indicated horse-power, speed, and consumption of fuel, of the steam-ships whose engines were the subjects of the experiments referred to in the original paper. Results are arrived at respecting the available heat of combustion of the coal employed, and the efficiency of the furnaces and boilers, of which the following is a summary :—

No. of Experiment.	Kind of Boiler.	Total heat of combustion of 1 lb. of coal in ft-lbs., estimated from chemical composition.	Available heat of combustion of 1 lb. of coal in ft-lbs. computed from efficiency of steam and weight of coal burned per I. H. P.	*Available heat*, total heat = efficiency of furnace and boiler.
I.	Improved Marine Boilers of ordinary proportions.	10,000,000	5,420,000	0·542
III.		10,000,000	5,300,000	0·53
II.	Boiler chiefly composed of small vertical water-tubes, with very great heating surface.	11,560,000	10,110,000	0·88

Available heat of combustion of 1 ℔. of coal

$$= \frac{1{,}980{,}000 \text{ ft.-℔s.}}{\text{Efficiency of steam} \times \text{℔. coal per I. H. P. per hour}}.$$

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* From the Lond., Edin., and Dub. Philosophical Mag., June, 1860.

For the Journal of the Franklin Institute.

Particulars of the Clipper Bark James Welsh.

Hull built by E. F. Williams, Greenpoint, L. I. Owner, F. Alexandre, New York City. Commander, Capt. W. Magill. Intended service, New York to Balize (Honduras).

HULL.—Length of keel, 110 feet. Do. of main deck, 120 feet. Do. over all, 129 feet. Breadth of beam at midship section, 28 feet. Depth of hold, 16 feet 6 inches. Frames of white oak and yellow pine, and very securely fastened. Tonnage, 350 tons, but possesses a frame equal to a vessel of 600 tons.

Remarks.—In the erection of this vessel, there have been many important improvements upon the old method of ship-building, particularly in its internal arrangements. Her forecastle is admirably adapted for the comfort of seamen, being far superior to the old and miserably ventilated ones, which have invariably been so detrimental to the health of sailors. It is erected on the main deck, having two gangways on each side of the chain lockers, and a commodious room on either side of the gangways, each possessing four large berths.

These gangways are sufficiently large to admit of five persons in each to be seated at meals, and can, when necessary, be used to change clothing and as a protection from storms, whilst the sleeping apartments will at all times keep perfectly dry.

Each of the rooms contains a ventilator, which, when used in concert with the hatch in the topgallant-forecastle and the gangways, will insure the presence of a continual current of fresh air.

The after-house of this vessel (constituting cabin and dining-room) is 28 feet in length, and contains four state-rooms on each side for the accommodation of passengers. The forward portion of the house is separated from the after part, for the purpose of stowing hides, dry goods, and miscellaneous merchandize, by which arrangement they receive a thorough ventilation during the passage, thereby preventing that unhealthy miasma arising, as is usually the case when such articles are stowed in the hold.

In addition to these features, there are two tanks in her cockpit of sufficient capacity to hold 500 gallons of water each. The main rail and bulwarks included, are seven and a half feet in height and of great strength, in order to protect her deck load, which, upon all her return voyages, will consist of mahogany.

The above improvements are the design of her owner, and are worthy the attention of ship builders, ship owners, and all others who are interested in alleviating the many trials and discomforts of a much abused and sadly neglected class—our sailors. E. B.

Safety of Vessels at Sea.

A Dr. Brevard, of Grenoble, describes in the *Cosmos* a means of preserving a ship from sinking at sea, which, although not new as a proposition, has never to our knowledge been adopted, and merits a fair experiment at all events. The plan appears to consist in rendering the various compartments of the vessel air-tight, and arranging proper openings along the keel which may be closed by plugs or stopcocks. If the vessel springs a leak, the compartment into which the leak opens is closed air-tight, and air forced in by a force-pump until the water is driven out at the leak, which is then to be stopped, and one or more of the escapes along the keel being opened, the air is continually forced in until all the water is expelled. Should fire take place below, the vessel may be scuttled by opening the lower escapes until the fire is extinguished, and be then raised again by means of the pumps. The same pumps may be used to ventilate the holds and cabins of the vessel. In a steamer the force-pumps may be worked either by connexion with the main engine or by the feed engine; and when it is considered that a pressure of one additional atmosphere will correspond to a column of about thirty feet of water, and that our india-rubber goods furnish a cheap and simple way of rendering any opening practically air-tight, the plan seems feasible enough; at all events, considering the important use for which it is purposed, deserving of serious study.

On the Explosion of Hypophosphite of Soda.[*] By M. TROMMSDORFF.

Under the heading of "Caution,"[†] Dr. L. C. Marquart describes a violent explosion of the above salt, while its solution was being evaporated in a porcelain capsule, placed in a heated sand bath, for which reason too high a heat was assigned as the cause of the explosion. It was therefore thought necessary to avoid evaporating such a solution, either over the fire or in a sand bath, but to employ altogether a water bath for its evaporation. This operation has been carried on very frequently in my laboratory without the occurrence of the least accident, but last spring I experienced by a painful accident that even the low temperature of boiling water is no safeguard against explosions of this salt.

The neutral solution of hypophosphite of soda was evaporated in small portions in a porcelain dish, heated by a simple water bath, the concentrated liquid being constantly stirred with a glass rod or a porcelain spatula. The last portion had become nearly dry, when a violent explosion took place, breaking all the windows of the laboratory and seriously lacerating the face of the attending workman. Being near at hand, and supposing the explosion to have been caused by the neglect of the water bath, I hurried to the spot, but found the bath filled with boiling water, and was unable to discover the least suspicious circumstance from which the cause of the accident might have been explained.

The preparation which the author is using now is of French manufacture, and has a strong alkaline reaction. Should it, in this state, be less subject to explosions, it would be highly interesting to hear of the experience of the French and other chemists with regard to this new medicinal salt, which they are preparing in enormous quantities.

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[*] From the Lond. Chemical News, No. 29.

[†] *Archiv d. Pharm.*, lxxxv, 384.

Improvement in the Manufacture of Starch.[*]

A patent has recently been obtained by John Hamilton, of Belfast, for submitting starch—after it is deposited in the manufacturing process—to the action of a hydraulic press, in suitable boxes, so as to press all the water out of it, instead of evaporating all the moisture in artificially heated rooms, according to the usual practice. A great saving in fuel is thus effected by well known and very simple means.

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[*] From the Lond. Chemical News, No. 10.

*Bitumenized "Paper" Pipes.**

The ingenious idea of hardening paper by means of an admixture of bitumen under the influence of hydraulic pressure, so as to convert it into a substitute for iron, is due, it appears, to M. Jaloureau, of Paris. The world has already become familiar with the utility and value of *papier maché* as a substitute for stone or marble in moulding, architectural castings, busts, and statues: it has also heard recently that the Chinese constructed their cannon of prepared paper lined with copper, and that they even make paper pipes,—that an eccentric character at Norwood has built himself a house of paper,—and that our American friends have invented a veritable paper brick;—but nothing, it is believed, has lately come before the British public, in the way of paper, so curious, and yet practicable, as these bituminous paper pipes. Testing experiments, conducted under the great clock-tower at the Houses of Parliament, are reported to have "proved that the material, while it possessed all the tenacity of iron, with one-half its specific gravity, had double the strength of stoneware tubes, without, moreover, being liable to breakage, as in the case of other material, and which frequently causes a loss to the contractor of some 20 or 25 per cent. on the supply." In order to test their strength, two of these bituminous paper pipes of 5-inch bore and half an inch thick were subjected to hydraulic power, and they are said to have sustained, without breaking or bursting, a pressure of 220 lbs. to the square inch, or equivalent to 506 feet head of water. The cost of the pipes is understood to be about one-half the cost of iron. Specimens of pipes employed in the transmission of gas at the Palace des Invalides during the last eighteen months were exhibited by Messrs. Joske & Young, the proprietors.

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* From the Lond. Builder, No. 888.

*Action of prolonged Heat and Water on different Substances.**

Mr. H. C. Sorby, an Englishman we believe, sends to the Academy of Sciences an account of some experiments he has made on the above subject. He put different substances and various solutions in glass tubes, sealed then hermetically, and then placed them in the boiler of a high pressure engine, and kept them there exposed to a temperature ranging from 145° to 150° C. for some months. Others he placed in an ordinary kitchen boiler, in which the temperature varied from 75° to 100° C. The first facts noticed are the decomposition of the glass tubes employed. Crown glass resisted the action best—better even than Bohemian—but it was sometimes acted on at but slightly elevated temperatures. English flint glass was easily decomposed by the prolonged action of water below 100°. A fragment of flint or Bohemian glass enclosed in a tube of crown glass with a *little* water, was more quickly decomposed than with much water. A moderately strong solution of nitric acid had little or no action on flint glass at 145° or 150°, while pure water soon changed it into a white crystalline mass. Wood exposed to a temperature of 145° without water, underwent but little change, while some with water became quite black. A brilliant black substance separated from the wood, but the water remained quite clear, although it had an acid reaction, due no doubt to acetic acid, and when the tube was opened a good deal of gas escaped. Some of the results obtained illustrate the pseudomorphosis of minerals, and of these experiments we hope the author will soon publish a fuller account.

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* From the Lond. Chemical News, No. 30.

AMERICAN PATENTS.

AMERICAN PATENTS ISSUED FROM JUNE 1, TO JUNE 30, 1860.

Air Engines,	O. M. Stullman,	Stonington,	Conn.	26
———	"	"	"	26
Amalgamator,	G. E. Mills,	City of	N. Y.	26
Apples,—Cutting and Coring	G. C. Wright,	Le Roy	Ohio,	26
Auger,—Tenoning	Wm. A. Clark,	Bethany,	Conn.	12
Bagasse Furnaces,	C. A. Desobry,	Plaquemine,	La.	19
Bark,—Separating Qualities of	Joseph Brakely,	City of	N. Y.	5
Barometers,	Lum Woodruff,	Ann Harbor,	Mich.	5
Barrels,—Securing Heads in	G. W. Banker,	Medford,	Mass.	12
Bed Bottom,—Spring	W A Morse & D S Beans,	Boston,	"	19
Bedstead,	Reuben Jenkins,	Covington,	Ky.	5
———	Thomas Wall,	Jones' Station,	Ohio,	5
Bee-hives,	K. P. Kidder,	Burlington,	Vt.	26
Bells,—Ringing	Balthasar Kitt,	Cincinnati,	Ohio,	5
Belts,—Strain on Pulley	Duff and Keating,	City of	N. Y.	19
Blind Slat Machine,	Stephen Jackson,	Ossippee,	N. H.	19
Blowers,	Rufus Lapham,	City of	N. Y.	19
Boats,—Hook for Suspending	C. L. Williams,	Quincy,	Fla.	5
Bolt for Doors,	N. W. Bonney,	Victoria,	Texas,	26
Bolts for Store Shutters,	Wm. C. Fisher,	Charlestown,	Mass.	26
Bolting Chest,	Cogswell & McKiernan,	Buffalo,	N. Y.	12
Boom Jaws,—Elastic Lining	O. P. Rowland,	Jamesport,	"	5
Bonnet Box,	C. A. Taylor,	Chicago.	Ill.	26
Boot-jack,	George Wheeler,	City of	N. Y.	26
Boot & Shoe Cleaning Appar.	James Chesley,	Concord,	N. H.	19
——— Wiper,	J. K. Staman,	Mifflin,	Ohio,	5
Boots,—Congress	H. S. Holmes,	Lynn,	Mass.	19
Boots & Shoes,—Heel Guard	W. A. Harris,	Providence,	R. I.	5
Brakes,—Railroad	Nehemiah Hodge,	N. Adams,	Mass.	12
———	J. H. Steiner,	Philadelphia,	Penna.	19
———,—Self-acting Wagon	Wm. May,	Winchester,	Ohio,	5
Bran Dusters,	J. W. Houghtelin,	Du Quoin,	Ill.	26
Bridges,—Iron	J. P. Fisher,	Rochester,	N. Y.	26
Bridle Bit,	Henry Crane,	City of	"	5
Bung Cutter,	John Tiebout,	Brooklyn,	N. Y.	5
Burglars Alarm,	J. C. Huntley,	Philadelphia,	Penna.	12
Butter Worker,	Wm. H. Wiley,	Lockport,	N. Y.	12
Buttons,	Stephen Krom,	City of	"	5
Cap Fronts,—Mode of Binding	Leon Londisky,	City of	N. Y.	26
Carpenters Square,	James Hathen,	Philadelphia,	Penna.	26
Carpet Stretcher,	H. M. Hartshorn,	Malden,	Mass.	26
Carpets,—Laying and Stretch'g	F. Cist and others,	St. Louis,	Mo.	12
Casting Metals,—Fac'g Moulds	J. B. Hyde,	Newark,	N. J.	5
Chains,	P. D. Cummings,	Portland,	Me.	5
Chisel for Opening Boxes,	D. M. Dumzack,	Salem,	Mass.	26
Chronometer Escapement,	Thomas Morrison,	Kingston,	N. Y.	12
Churn,	N. D. Ross,	Braintrem,	Penna.	5
———	O. W. Stanford,	Cincinnati,	Ohio,	12
———	Harry Abbott,	N. Huron,	N.Y.	19

Churn,	S. A. Kerr,	Arbor Hill,	Va.	19
———	C. Wright & W. Phelps,	Sycamore,	Ill.	19
Claw Bar,	G. H. Beard,	Cincinnati,	Ohio,	12
Clothes Wringer,	Higgins & Willard,	Somerville,	Mass.	19
Clocks,—Calendar	Eben Pritchard,	Waterbury,	Conn.	5
Cocks,—Pull	George Leach,	City of	N. Y.	5
Coffee Pots,	Thomas Yates,	Dubuque,	Iowa,	19
Core Boxes,	J. S. Harper,	Baltimore,	Md.	5
Cornices of Sheet Metal,—Form.	John Lee,	Bolivar,	Ohio,	12
Corn Huskers,	D. M. Mefford,	Jeffersonville,	Ind.	26
—— and Cob Crushers,	Amos Glover,	Powhatan Pt.,	Ohio,	5
—— Planters,	Daniel Moyer,	N. Hamburgh,	Penna.	5
———	Ptollman Stover,	W. Alexandria,	Ohio,	5
———	Davis Dutcher,	Blue Grass,	Iowa,	26
———	T. S. Mills,	Iberia,	Ohio,	26
———	Levi Morris,	Woodbury,	Ill.	26
———	D. C. Myers,	Richmondale,	Ohio,	12
———	J. L. Smith,	Neoga,	Ill.	26
———	Taylor & Sprague,	Prairie City,	"	26
—— Shellers,	E. A. Smead,	Tioga,	Penna.	5
———	J. P. Smith,	Hummelstown,	"	19
Cotton Bales,—Iron Tie for	C. C. Bier,	New Orleans,	La.	26
——— Scrapers,	J. M. Cobb,	Jackson,	Tenn.	26
Coupling and Uncoupling Cars,	Wm. A. Herrick,	Leeds,	Me.	19
Couplings,—Car	J. S. Sammons,	City of	N. Y.	5
———	L. and W. H. Waddel,	Staunton,	Va.	5
———	Wm. W. Culpepper,	Augusta,	Ga.	12
——— for Railroad Cars,	George Lavally, Jr.,	Champlain,	N. Y.	26
Coupling for Shafting,	Samuel Hall,	City of	"	5
———	H. L. Haynes,	Keene,	N. H.	26
Cultivator Teeth,	C. H. Sayre,	Utica,	N. Y.	19
———	Turner & Smith,	Sunapee,	N. H.	26
Cultivators,	Vines Harwell,	Walker Co.,	Ga.	5
———,—Cotton	W. F. Johnson,	Wetumpka,	Ala.	5
———	R. M. Brooks,	Greenville,	Ga.	26
———	J. F. Cameron,	Livingston Co.,	Mo.	26
———	James Charlton,	Alleghany,	Penna.	26
———	O. F. Fitch,	Morristown,	Ind.	26
———	T. and R. Kinghorn,	Morgan,	Ohio,	26
———	J. M. Williams,	Greenville,	Ga.	26
Cup,—Telescopic Drinking	P. H. Niles,	Boston,	Mass.	5
Cut-off for S'm. Engs.,—Variable	David Fellenbaum,	Lancaster,	Penna.	5
Currying Knife,	Wm. P. Moses,	Exeter,	N. H.	5
Curtain Slide,—Window	Gregor Trinks,	Jersey City,	N. J.	26
Cutlery,—Soldering Handles of	E. A. Godfrey,	Hartford,	Conn.	12
———	"	"	"	12
Dating Machine,	G. J. Hill,	Buffalo,	N. Y.	26
Ditching Machines,	P. W. Adaire,	Hays' Creek,	Miss.	5
Dove-tailing Machines,	H. W. Jelliff,	Appleton,	Ohio,	12
Drills,—Rock	E. L. Foote,	Springfield,	Ill.	5
Drill Rest,	Cornelius Teachout,	Waterford,	N. Y.	19
Dry Dock,—Marine	H. J. Crandall,	New Bedford,	Mass.	12
Dulcimers,	John Low,	Clinton,	"	19
Dynanometers,	Warren & Damon, Jr.,	Boston,	"	26
Eave Troughs,—Making	Ludlow Pierson,	Jeffersonville,	Ind.	26
Egg Beater,	McLean & Morley,	City of	N. Y.	19
Electricity,—Utilizing Atmos.	H. C. Vion,	Paris,	France,	19
Envelope,	Benjamin Morrison,	Philadelphia,	Penna.	19
Faucets,	D. H. Thorp,	Chelsea,	Mass.	19
———	I. C. Tate,	New London,	Conn.	12
Fenders for Docks, Wharves, &c.,	Jacob Moomey,	Clinton,	Iowa,	19

Fibrous Materials,—Surfacing	Wm. Fuzzard,	Charlestown,	Mass.	19
Files,—Manufacture of	M. D. Whipple,	Charlestown,	Mass.	26
Filters,	T. C. Simonton,	Paterson,	N. J.	26
Fire Arms,—Self-loading	N. W. Brewer,	Williamsport,	Penna.	12
————	James Lord,	Minersville,	"	12
—— Brick,	Eben Seavey,	Boston,	Mass.	12
—— Engines,—Nozzle for	J. C. Howels,	Madison,	Wis.	26
—— Escape,	W. B. Avery,	Cambridge,	Mass.	5
————	C. W. Crosley,	City of	N. Y.	19
————	J. J. Holwell,	"	"	26
————	Wm. McCord,	Sing Sing,	"	26
————	Patten and Terry,	Albany,	"	26
—— Wood,—Bundling	C. J. Hobe,	City of	"	19
Flour,—Machines for Packing	S. A. Clapp,	Hamilton,	Ill.	5
Fog Alarms,	C. L. Daboll,	New London,	Conn.	26
Fruit,—Apparatus for Drying	Isaac Randall, 2d,	Claremont,	N. H.	19
Fruits,—Machine for Stoning	Robert McCormick,	Greenville,	Va.	26
Furnaces,	C. F. Baxter,	Boston,	Mass.	19
Furniture,—Folding	Albert Tracy,	U. S. A.,	——	12
————,—Polish for	André Sabatier,	City of	N. Y.	19
Gauge for Filling Barrels,	W. H. Noyes,	Boston,	Mass.	5
Game-box,	S. F. Brooks,	Weston,	"	19
Garter,	J. P. Fuller,	City of	N. Y.	26
Gas Burners,	Wendell Wright,	"	"	12
————	Woodworth & Wethered,	San Francisco,	Cal.	12
————	James McGlensey,	Philadelphia,	Penna.	19
—— Holders,	O. L. Lawson,	City of	N. Y.	26
——,—Manuf. of Illuminating	Levi Short,	Buffalo,	"	12
—— Metres,—Liquids for Fluid	James Taylor,	Dartmouth,	Mass.	5
—— Regulators,	S. H. Whitaker,	Cincinnati,	Ohio,	12
——,—Broiling or Roasting by	W. F. Shaw,	Boston,	Mass.	19
—— Tubes,—Flexible	John Butler,	Brooklyn,	N. Y.	12
Gases,—Naphthalizing	E. H. Ashcroft,	Boston,	Mass.	5
Gearing,	P. D. Cummings,	Portland,	Maine,	5
Grain Binders,	Herman Kaller,	Perry,	Ill.	5
————	W. W. Burson,	Yates City,	"	26
——— Separators,	McGahey and Foote,	McGaheysville,	Va.	12
Grindstones,—Dressing	J. F. Schuyler,	Philadelphia,	Penna.	5
Gun,—Toy	W. H. Stevens,	Syracuse,	N. Y.	12
Hame Tug and Buckle,	J. S. Topham,	Washington,	D. C.	12
Harrows,	D. C. Colby,	Newport,	N. H.	26
————	S. A. and C. C. Morgan,	Auburn,	N. Y.	26
Harvesters,	Robert Bryson,	Schenectady,	"	5
————	S. and J. H. Barley,	Longwood,	Mo.	19
————	Joseph Woodruff,	Rahway,	N. J.	5
————	Benaiah Titcomb,	Baltimore co.,	Md.	5
————,—Automatic Rakes	John Ollis,	Bloomington,	Ill.	26
————,—Raking Attachment	Daniel Guptail,	Elgin,	"	26
————,——— Apparatus	A. B. Smith,	Clinton,	Penna.	19
Hat Conformatures,	John Dickson, Jr.,	Brooklyn,	N. Y.	5
—— Cushion,	A. D. Purinton,	Dover,	N. H.	26
Hats,—Cigar Rack for	F. I. Miller,	Brooklyn,	N. Y.	19
Hay Elevators,	Wm. E. Durkee,	Fort Edward,	"	12
——,—Loading	Wm. Dixon,	Chicago,	Ill.	26
————	T. J. Jolly,	Olean,	Ind.	26
——,—Unloading	H. H. Angell,	Clermont,	Iowa,	26
Heating Air by Steam,	James Hollingsworth,	Chicago,	Ill.	5
——— Apparatus,	Lyman Bridges,	"	"	19
Hinges,	A. W. Sweeny,	Washington,	D. C.	26
Hinge,	H. M. Zimmerman,	"	"	26
Hook,—Self-mousing	J. R. Henshaw,	Middletown,	Conn.	12
Horse-powers,—Gearing for	Cyrus Avery,	Tunkhannock,	Penna.	5

Horse-shoes,	T. M. Coleman,	Philadelphia,	Penna.	12
Hose Pipe,	George Smith,	Macon,	Ga.	12
Hot-air Engine,	Wm. D. Grimshaw,	Newark,	N. J.	19
Hydrants,	Alfred Johnson,	Philadelphia,	Penna.	12
India Rubber,—Treatment of	A. K. Eaton,	City of	N. Y.	19
Inoculating,—Apparatuses for	Alfred Stauch,	Philadelphia,	Penna.	12
Jars,—Moulds for	George Scott,	Cincinnati,	Ohio,	5
Key Seats,—Mach. for Cutting	W. C. Bement,	Philadelphia,	Penna.	5
Lamps,	E. J. Hale,	Foxcroft,	Me.	12
———	Jennison and Hale,	"	"	12
———	Chas. Miller,	St. Louis,	Mo.	12
———	O. and H. S. Snow,	West Meriden,	Conn.	12
———	E. J. Hale,	Foxcroft,	Me.	19
———	"	"	"	26
———,—Coal Oil	R. S. Merrill,	Lynn,	Mass.	19
———,—Vapor	Joseph Clarke,	Syracuse,	N. Y.	12
—————	C. W. Richter,	Madison,	Ga.	12
—————	George Walker,	Philadelphia,	Penna.	26
Lath Machines,	McLean & Gummer,	Indianapolis,	Ind.	26
Leather,—Buffing and Reducing	Joshua Turner,	Cambridgeport,	Mass.	5
———,—Finishing	S. P. Cobb,	S. Danvers,	"	5
———,—Skiving	E. T. Ingalls,	Haverhill,	"	5
Leather-splitting Machs.,—Feed	D. H. Chamberlain,	West Roxbury,	"	5
Lifting Handles,	Joseph Ottner,	New Britain,	Conn.	26
Light Joints,—Drop	T. G. Arnold,	City of	N. Y.	5
Lock,	E. W. Brettell,	Newark,	N. J.	26
Locks,	Linus Yale, Jr.,	Philadelphia,	Penna.	12
Lozenge Machines,	Rhoda Sowle,	Fall River,	Mass.	19
Lubricating Journals,	Andrews & Carr,	Palo Alto,	Penna.	19
Medical Compound,	J. J. Reeves,	Sulphur Sp'gs,	Texas,	26
Measuring Liquids,—Appa's for	Hiram James,	Barclay,	Ill.	5
——————————	John C. Rankin,	Mt. Vernon,	N. Y.	12
Mills,	Leonard Coleman,	New Orleans,	La.	12
——	E. D. Clark,	Earlville,	N. Y.	26
——	H. C. Velie,	Poughkeepsie,	"	26
——,—Grinding	Samuel Moore,	Wellsburgh,	Va.	12
Millstones,—Dressing	Joel Bowman,	Somerset,	Ohio,	5
Millstone Dress,	J. W. Gaines,	Melrose,	Texas,	26
Millstones,—Cooling, &c.,	Akins and Babcock,	Dryden,	N. Y.	12
Mirrors,—Silvering	H. Poissonniér,	City of	"	19
Mowing Machines,	Chester Bullock,	Jamestown,	"	5
Nail-cutting Machine,	Wm. Wickersham,	Boston,	Mass.	26
Neck Stock,	Wm. Watson,	Lowell,	Ind.	12
Needles,—Machine for Making	Frederic Plant,	City of	N. Y.	19
Newspaper File,	J. N. Jacobs,	Worcester,	Mass.	19
Oil from Resin,—Distillation of	Samuel Frazer,	Galena.	Ill.	12
Ores and Coal,—Desulphurizing	Wm. H. Letterman,	Philadelphia,	Penna.	26
—— of Gold, &c.,—Treating	John McCullock,	San Francisco,	Cal.	26
Paddle Wheel,—Feathering	R. Williams & S. Wilson,	Buffalo,	N. Y.	12
Paints,—Mixing	S. G. Cheever,	Boston,	Mass.	5
Paper,—Machine for Wetting	Andrew Overend,	Philadelphia,	Penna.	26
Pegging Machines,	J. J. Greenough,	City of	N. Y.	26
Pen and Pencil Case,	G. E. Frew,	Brooklyn,	"	12
Pen-holder,	A. F. Warren,	"	"	19
Photographic Baths,	Wm. and Wm. H. Lewis,	City of	"	26
————— Cameras,	E. M. Corbett,	"	"	19
Piano-forte Hammers,—Covers	Jehiel Munson,	Burlington,	Vt.	19
Picks,	J. C. Reed,	Cincinnati,	Ohio,	5
Pitcher,—Beer	O. Z. Pelton,	Middletown,	Conn.	19

Pitchers,—Spout and Lid of	David Baker,	Harwich,	Mass.	19
Planing Warped Surfaces,	John Green,	Brooklyn,	N. Y.	19
Plane-iron Sharpeners,	Joshua Turner,	Cambridgeport,	Mass.	26
Ploughs,	Whitman Price,	Wayne Co.,	N. C.	5
———	C. F. Richter,	Columbia,	S. C.	5
———	R. S. Williams,	Bairdstown,	Ga.	26
———	T. R. Markillie,	Winchester,	Ill.	19
———	Pomeroy & Hudson,	Providence,	R. I.	12
———	J. M. Cobb,	Jackson,	Tenn.	26
———,—Moles for Drain	Hawkins & Puntenney,	Canton,	Ill.	12
———	Shipp & Crenshaw,	La Grange,	Tenn.	26
———	J. P. Thompson,	Jackson,	"	26
———,—Steam	Albert Bigelow,	Hamilton,	C. W.	19
—————	L. B. Woolfolk,	Nashville,	Tenn.	19
—————	"	"	"	26
Plumbers Joints,—Making	J. P. Hayes,	Philadelphia,	Penna.	19
Porter Bottle Boxes,	G. W. Righter,	"	"	5
Post-hole Diggers,	John Lee,	Bolivar,	Ohio,	26
Preserving Meats,	G. W. Oliver,	City of	N. Y.	19
Printing Press,	M. S. Beach,	Brooklyn,	"	26
————	G. C. Howard,	Philadelphia,	Penna.	26
————	Smith & Orvis,	Oakfield,	Wis.	26
————	A. B. Taylor,	Newark,	N. J.	26
Presses,—Cotton	George Milliran,	Byhalia,	Miss.	5
Propeller,—Marine	D. D. Porter,	U. S. N.,		12
Prussian Blue,	James Clark,	Newark,	N. J.	12
Pumps,	N. S. Bean,	Manchester,	N. H.	12
———	George Palmer,	Littlestown,	Penna.	5
———, &c.,—Air Vessels of	A. H. Rauch,	Bethlehem,	"	5
———	Edward Wade,	Norwich,	Conn.	12
Quartz-crushers,	Philip Estes,	Leavenworth,	K. T.	12
Quartz,—Stamping Metal	Gates and Frazer,	Chicago,	Ill.	19
———,—Machines for Crushing	F. N. Du Bois,	"	"	26
Railroad Car Trucks,—Bolsters	M. C. Andrews,	Lawrence,	Mass.	5
——— Wheels,	J. H. Steiner,	Philadelphia,	Penna.	19
——— Station Indicators,	E. M. & J. E. Woodward,	"	"	26
——— Cars,—Sprinkl'g attach.	Henry Mitchell,	Cincinnati,	Ohio,	19
Railroads,—Iron Rails for Street	S. A. Beers,	Brooklyn,	N. Y.	19
Rakes,—Bending Teeth for	Henry Brandt,	Columbia,	Penna.	5
Reaping and Mowing,	Daniel Sheets and others,	Suisun City,	Cal.	19
Roofing Houses,—Composition	J. A. Hawley,	Jackson,	Mich.	5
Roots,—Houses for Preserving	T. V. Bush,	Gallatin,	Tenn.	5
Rotary Engines,	T. H. Witherby,	Worcester,	Mass.	5
————	J. Rix & J. S. Shaw,	Springfield,	Mo.	26
Saccharine Juices,—Evaporating	Gilbert & Ames,	Bayou Goula,	La.	5
Saddle,—Military	W. H. Jenifer,	Baltimore,	Md.	26
Sad-iron Heater,	W. J. Andrews,	Columbia,	Tenn.	5
Safes,—Composition for Lining	Jabez Jenkins,	Philadelphia,	Penna.	19
Sails,—Securing Reef Points of	J. W. Logan,	"	"	5
Sash-fastener,	Lafayette Bartoo,	East Aurora,	N. Y.	19
Sausage-filler,	J. G. Perry,	S. Kingston,	R. I.	26
Scroll-sawing Machine,	W. P. Wood,	Washington,	D. C.	19
Saws,—Grinding	Wm. Dougherty,	Philadelphia,	Penna.	19
——,—Sharpening	John Armour,	Helena,	Ark.	5
——,—Tabs for Cross-cut	T. S. Disston,	Philadelphia,	Penna.	5
Screws and Nuts,—Anti-friction	C. F. Spencer,	Rochester,	N. Y.	5
———,—Die-plate for Cutting	E. P. Gleason,	Providence,	R. I.	19
Seats,—Adjustable Carriage	I. L. Vansant,	Red Lyon,	Del.	19
——————	J. A. Naylor,	Rahway,	N. J.	26
Seed Planters,	H. C. Fairchild,	Brooklyn,	N. Y.	5
————	James Green,	Kennett Sq.,	Penna.	5

Seed Planters,	A. J. Rogers,	Stephentown,	N. Y.	19
———	Hervey Sloan,	Franklin,	Ind.	26
———	David Warren,	Gettysburgh,	Penna.	26
———	Elijah Young,	Fayetteville,	Mo.	26
Seeds,—Planting Cotton	Whitman Price,	Mount Olive,	N. C.	5
———	Benjamin Owen,	Dayton,	Ohio,	26
———	W. A. and J. F. Suddith,	Charlestown,	Va.	26
Seeding Machines,	Matthew Mitchell,	Altona,	Ill.	5
———	M. B. Rupp,	McVeytown,	Penna.	19
———	D. W. M. Lower,	Albia,	Iowa,	26
———	Joseph Sutter,	City of	N. Y.	26
———	Thomas Wilson,	Winterset,	Iowa,	26
———	Wm. Workman,	Ripon,	Wis.	26
Sewing ———	Scofield and Rice,	Adams,	N. Y.	5
———	W. H. Smith,	Birmingham,	Conn.	19
———	Joseph Geiermann,	Albany,	N. Y.	19
———	I. M. Rose,	City of	"	19
———	J. S. Steiner,	St. Louis,	Mo.	19
———	E. S. Yentzer,	Middletown,	Penna.	19
———	J. E. A. Gibbs,	Mill Point,	Va.	26
———	Austin Leyden,	Atlanta,	Ga.	26
———	Fr. Toggenburger,	Chicago,	Ill.	26
———,—Guides for	Wm. Price,	City of	N. Y.	19
———	Wm. Rankin,	Richmond,	Va.	19
———,—Hemmers	W. P. Mitchell,	Baltimore,	Md.	26
———,—Marking in	H. W. Fuller,	Brooklyn,	N. Y.	5
———,—Shuttles	George Juengst,	City of	"	26
———,—Starting	T. J. Alexander,	Westerville,	Ohio,	12
Shingle Machines,	McLean and Grummer,	Indianapolis,	Ind.	5
———	J. D. Chism,	Albany,	N. Y.	12
———	E. T. Wheeler,	Cannelton,	Ind.	19
Shingles from Bolt,—Sawing	J. M. Carlisle,	Greenwood,	S. C.	19
Ships Windlass,	A. I. Gove,	San Francisco,	Cal.	12
Shoe Tips,—Cutting Blanks for	G. A. Mitchell,	Turner,	Me.	26
———,—Swaging	"	"	"	26
Shutter Operator,	Chas. Seltman,	Washington,	D. C.	26
Skirt Hoops,	Stokes & Jones,	City of	N. Y.	12
Skirts,—Making Hoop	Cæsar Newman,	"	"	26
———,—Manufacturing Skeleton	F. S. Otis,	Brooklyn,	"	5
———,—Skeleton	S. S. Sherwood,	City of	"	26
Sleighs,—Attach. Whiffletrees to	A. P. Hutchinson,	Pembroke,	N. H.	26
Spoke Machines,	Stam and Shubert,	Sardinia,	Ohio,	19
Spring Balances,	Wm. A. Crowell,	Salisbury,	Conn.	26
———,—Door	Jacob Post,	Newark,	N. J.	12
Springs,—Car	Richard Vose,	City of	N. Y.	5
———	"	"	"	12
———,—Tempering Steel	C. G. & H. M. Plympton,	Walpole,	Mass.	5
Stave Machine,	Wm. Trapp,	Elmira,	N. Y.	12
Steam Boiler,	J. S. Colvin,	Pittsburgh,	Penna.	12
——— Boilers,	M. R. Clapp,	Seneca Falls,	N. Y.	12
———,—Alarm Gauge	E. A. Kimball,	Boston,	Mass.	19
———,—Explosion of	H. L. Justice,	Nashville,	Tenn.	12
———,—Feed-water	Ephraim Pierce,	Cincinnati,	Ohio,	12
———	Wm. C. Drum,	Bellevernon,	Penna.	26
——— Engines,—Reg. Exhaust	James Thierry,	Detroit,	Mich.	26
———,—Slide Valves	E. M. Lewis,	Philadelphia,	Penna.	12
——— Pressure Gauge,	Wm. H. Allen,	Brooklyn,	N. Y.	19
——— Radiators,	A. P. Pitkin,	Hartford,	Conn.	12
——— Stuffing-box for Rolls,	Hugh Campbell,	Newtown,	"	12
——— Trap,	C. C. Walworth,	Boston,	Mass.	19
——— Valve,	Leopold Bennett,	Pittsburgh,	Penna.	5
Steering Apparatus,	A. D. Rollins,	Green Point,	N. Y.	19
Stills,	S. Godfrey and others,	Fairfield,	Ohio,	26

Stop-cocks,	Robert Nicoll,	City of	N. Y.	5
Stoves,	W. H. Smith,	Newport,	R. I.	19
———.—Cooking	S. S. Jewett,	Buffalo,	N. Y.	12
———————	A. S. Sterling,	"	"	19
Stump Extractors,	A. Broughton,	Malone,	"	19
———————	John Hamlyn,	Bellevue,	Mich.	26
———————	Nathan Parish,	Galesburgh,	"	26
Sugar,—Clarifying	H. G. C. Paulson,	City of	N. Y.	19
———.—Machine for Cutting	T. H. Quick,	"	"	26
Sulphurous Acid,—Manufac. of	Marcelin & Eude,	New Orleans,	La.	12
Table Plate,	D. H. Shirley,	Boston,	Mass.	12
Tin Boxes,—Making	C. J. Haywood,	Durham,	Conn.	5
Tires,—Heating Wagon	I. N. Whitaker,	Foreston,	Ill.	12
——.—Upsetting	Henry Barringer,	Wataga,	"	19
Tobacco Press,	John Sweeney,	Chicago,	"	26
Tooth Brush,	H. N. Wadsworth,	Washington,	D. C.	19
Torch for Night Processions,	Isaac Edge,	Jersey City,	N. J.	12
Torches,—Gas	G. C. Brower,	New Orleans,	La.	5
Trap,—Animal	Wm. Wright,	Philadelphia,	Penna.	19
Tubes,—Coat. for inter. of metal	John Matthews, Jr.,	City of	N. Y.	5
Turbine Wheels,—Hanging	A Warren & E Damon, Jr.,	Boston,	Mass.	5
Tweer,	Marvin Mead,	Bedford,	Mich.	12
Type,—Setting,	Henry Harger,	Delhi,	Iowa,	26
——,—Scouring	J. G. Pavyer,	St. Louis,	Mo.	26
Typography,	Villet-Collignon & George,	Paris,	France,	12
Ventilation of Casks,	Louis Wilhelm,	Buffalo,	N. Y.	19
Vehicles,—Shafts to two-wheel	H. M. Walker,	Watertown,	Conn.	19
Vulcanizing Rubber,	G. E. Hays,	Buffalo,	N. Y.	12
Washboard,	Isaac Cook,	Mt. Pleasant,	Iowa,	5
Washing Machine,	H. Ehrman and others,	Annville,	Penna.	5
———————	J. W. Crane, Jr.,	Freeport,	Ill.	12
———————	P. Z. Allen,	Knox,	N. Y.	26
Watch Chains,	C. B. Carpenter,	N. Attleboro',	Mass.	19
——— Chain Hook,	E. N. Foote,	City of	N. Y.	26
——— Key and Guard Bar,	D. F. Elmer,	Haydenville,	Mass.	26
Watches,—Constructing Rims	C. W. Clewley,	Providence,	R. I.	19
Water Closets,	Thomas Grundy,	Boston,	Mass.	26
——— Elevators,	John Champlin,	E. Middlebury,	Vt.	26
——— in Pipes,—Reg. pressure	James Stratton,	Brooklyn,	N. Y.	5
——— Wheel,	A. Morehouse,	Farmer,	"	12
——— Wheels,	Caleb Bond,	Richmond,	Ind.	26
Weighing and Bagging Grain,	J. M. Fish,	Buffalo,	N. Y.	5
Willows, &c.,—Removing Bark	L. A. Beardsley,	S. Edmeston,	"	26
Window Blinds,	C. W. Smith,	Evans,	"	26
——— Curtain,	G. L. Kelty,	City of	"	5
Windmills,	Walter Peck,	Rockford,	Ill.	19
Wire Rope,—Making	Cornelius Collins,	Brooklyn,	N. Y.	19
Wood and Metal,—Finishing	George Stover,	New Britain,	Conn.	19
Wrench,	A. T. Gove,	San Francisco,	Cal.	12

EXTENSIONS.

Dredging Machines,	Carmichael & Osgood,	Brooklyn,	N. Y.	5
Stoves,—Cooking	R. D. Granger,	Albany,	"	12

ADDITIONAL IMPROVEMENTS.

Cakes,—Cutting and Panning	J. H. Shrote,	Baltimore,	Md.	26
Molding Machines,	E. M. Smith,	Shelbyville,	Ind.	26
Quartz,—Crushing	J. C. Dickey,	Saratoga Sp'gs,	N. Y.	12
Skates to Boots,—Attaching	T. S. Whitman,	City of	"	19
Steering Apparatus,	Daniel Jones,	Boston,	Mass.	26
Tile,—Laying Drain	B. B. Briggs,	Sharon,	Ohio,	26

RE-ISSUES.

Corn-shellers,	Nathaniel Drake,	Newton,	N. J.	12
Grass,—Machines for Cutting	C. H. McCormick,	Chicago,	Ill.	5
———————	"	"	"	5
———————	"	"	"	5
Hair Brush Handles,—Finishing	Thomas Mitchell,	Lansingburgh,	N. Y.	26
Harvesters,—clover & grass seed	W. N. Whitely, Jr.,	Springfield,	Ohio,	19
———————	"	"	"	19
———————	"	"	"	19
————,—Grain & Grass	Jacob Swartz,	Buffalo,	N. Y.	5
———————	Cyrenus Wheeler, Jr.,	Poplar Ridge	"	5
Hose Pipe,—Coating for	N. Y. Rubber Company,	City of	"	5
India Rubber,—Vulcanizing	J. P. Trotter,	"	"	19
Lenses,—Fluid	Seligman Kakeles,	"	"	26
Reaping & Mowing Machines,	C. H. McCormick,	Chicago,	Ill.	5
———————	"	"	"	5
———————	"	"	"	5
Reflector,—Night-light	John Wyberd,	City of	N. Y.	12
Skeleton Hoop Skirts,	Cæsar Newmann,	"	"	26
Railroad Cars and Carriages,	P. G. Gardiner,	"	"	12
Steering Apparatus,	Wm. Godsoe,	Manchester,	Mass.	12
Water-closet,	Wm. S. Carr,	City of	N. Y.	12
Water Wheel,	J. P. Collins,	Troy,	"	12
Window Stop,	Williams & Heaton,	Providence,	R. I.	12

DESIGNS.

Bust of Abraham Lincoln,	L. W. Volk,	Chicago,	Ill.	12
Carpet Patterns,	E. J. Ney,	Lowell,	Mass.	12
——— Pattern (11 cases),	H. G. Thompson,	City of	N. Y.	19
Carpets,	E. J. Ney,	Lowell,	Mass.	12
Decanter Stoppers,	Wm. Pountney,	City of	N. Y.	19
Fire Shovel (4 cases),	Lemuel Morgan,	S. Norwalk,	Conn.	19
Nut-cracker,	S. G. Smith,	City of	N. Y.	12
Pump,	Birdsill Holly,	Lockport,	"	19
Range,—Cooking	A. C. Barstow,	Providence,	R. I.	12
———,—Cook's	Gardiner Chilson,	Boston,	Mass.	12
Roofs,—Ornamental Ridge	J. L. Jones,	Slatington,	Penna.	12
Stove,	S. W. Gibbs,	Albany,	N. Y.	12
——,—Cook's,	N. S. Vedder,	Troy,	"	12
——,—Cooking	R. H. N. Bates,	Providence,	R. I.	12
——,—Parlor	Louis Meyer,	St. Louis,	Mo.	19

FRANKLIN INSTITUTE.

Proceedings of the Stated Monthly Meeting, August 20, 1860.

John Agnew, Vice-President, in the chair.

Isaac B. Garrigues, Recording Secretary.

The minutes of the last meeting were read and approved.

Letters were read from the Royal Society of London, and from the State Librarian of Pennsylvania, Harrisburgh, Penna.

Donations to the Library were received from the British Government, the Royal Society and the Statistical Society, London; the Royal Cornwall Polytechnic Society, Falmouth, England; the Nieder-Osterreichischen Gewerbe Vereines, Vienna, Austria; the Smithsonian Institution, and the Hon. P. F. Thomas, Commissioner of Patents, Washington, D. C.; the Maryland Agricultural College, Prince George's County, Maryland: Wm. J. Lewis, Esq., San Francisco, California; Dr. Chas. M. Wetherill, Lafayette, Indiana; Messrs. Little, Brown & Co., Boston, Mass.; Messrs. C. W. Eliot and F. H. Storer, Cambridge, Mass.; J. S. Homans, Esq., and the Mercantile Library Association of the City of New York; the Mercantile Library Association of Brooklyn, New York; and Prof. John F. Frazer, Philada.

The Periodicals received in exchange for the Journal of the Institute, were laid on the table.

The Treasurer's statements of the receipts and payments for the months of June and July were read.

The Board of Managers and Standing Committees reported their minutes.

Four resignations of membership in the Institute were read and accepted.

Candidates for membership in the Institute (12) were proposed, and the candidates proposed at the last meeting (5) duly elected.

Mr. Howson exhibited a specimen of a hand-saw manufactured by Mr. H. Disston, of the "*Keystone*" Saw Works of this city.

In form and weight it differed but little from hand-saws of ordinary construction; it is, however, by its peculiar construction, rendered available as a rule, a square, a level, and a plumb-rule. On the handle of the saw are formed two shoulders at right angles to the back edge of the blade, thus converting the instrument into a square. In the handle are let two spirit tubes, one being placed at right angles to, and the other parallel with the back edge of the blade, so that the latter can be applied as a level or plumb-rule, the blade itself being graduated into feet and inches for ordinary measuring purposes.

Mr. Howson also exhibited a specimen of fractured brass submitted by Mr. T. Shaw, of this city. The specimen consists of a disk, three inches in diameter and about one-fourth of an inch thick, with a central hub on one side. The fracture (which appears to have taken place while the metal was being turned in a lathe) consisted of the entire separation of a piece varying from one-thirty-second to one-sixteenth of an inch in thickness from the main body of the disk, the fracture being nearly in a plane parallel with the face of the disk.

The President remarked that although the specimen was a curious one, such fractures were not unusual; that it was no doubt owing to some hesitation in pouring the molten metal into the mould, an opinion concurred in by members present.

Mr. H. also exhibited a specimen of a boot, the leg and foot of which was made of one piece of leather folded together and presenting a single seam. The specimen was submitted by Mr. Michael Fritz, No. 1218 Whitehall St., the agent in this city for the inventor and patentee, Mr. Peter Keffer, of Reading, Pa.

The inventor says a pair of boots can be made after this manner in the time it takes to crimp the leather in the old way, and prevents the strain on the uppers to which crimping subjects them.

Mr. George Munro exhibited a specimen of a shoe made for a deformed foot, and illustrated the advantages of his mode of forming lasts from casts made from the foot.

BIBLIOGRAPHICAL NOTICE.

The Institutes of Medicine. By MARTYN PAINE, A. M., M. D., LL. D., Professor of the Institutes of Medicine and Materia Medica in the University of the City of New York, &c.: Fifth Edition—New York, Harper & Brothers.

The Institutes of Medicine treats of those broad principles of science concerned in the development, preservation, and perfection of the living organism. It includes more especially those particular branches of medical science known as physiology, pathology, hygiene, and therapeutics, and constitutes, in fact, the philosophy of medicine. Its object is to thus determine the laws of health and disease, and point out the means of preserving the former, and resolving as well as preventing the latter. In the work before us, an elaborate effort has been made to unfold these great principles of medical philosophy, yet, notwithstanding its author is one of the most erudite and accomplished medical writers of the day, the doctrines taught therein are now generally regarded as representing the knowledge of the past rather than of the present. Nevertheless, this work contains so much useful information upon the subject of which it treats as to render it very valuable, not only to physicians but to all others interested in medicine. Z.

METEOROLOGY.

For the Journal of the Franklin Institute.

The Meteorology of Philadelphia. By JAMES A. KIRKPATRICK, A.M.

JULY.—The temperature of the month of July was a little more than one degree below the average for the last ten years, and a little less than one degree higher than that of July of last year. The warmest day was the 20th, of which the mean temperature was 87·7°, and the thermometer was highest on the same day, indicating a maximum temperature of 95½°. The coldest day was the 6th of the month, of which the mean temperature was 64·2°. The thermometer was lowest on the morning of the 7th, giving the minimum for the month 57°. The oscillations of temperature and the mean daily range of the thermometer were considerably greater than usual, though very nearly the same as for the month of July last year.

The pressure of the atmosphere was less than usual, the barometric column standing five-hundredths of an inch lower than the average of the month for ten years. The minimum (29·495 inches) occurred on the afternoon of the 5th, and the maximum (29·979 inches) on the morning of the 28th, showing for the whole month a range of less than half an inch. The only approach to a storm that happened during the month, occurred early on the morning of the 27th, and was very severe in the northern part of the city and the neighboring counties, where the lightning, which was very vivid, struck in several places. The wind was high, and the rain is said to have fallen in unusual quantities. In the centre of the city less than two-tenths of an inch of rain fell on that morning.

The number of days on which rain fell was about the same as usual, but the quantity falling at each time was very small, in no case exceeding three-tenths of an inch. The quantity that fell during the whole month was less than seven-eighths of an inch, and less than has fallen during any July for the last ten years. The next lowest amount was in July, 1856, when an inch and one-eighth fell.

There was not one day of the month entirely clear, and but two days on which the sky was completely covered with clouds at the hours of observation.

The force of vapor and relative humidity for the month still continued considerably below the average, both for the last year and for the last ten years.

The atmosphere on the 18th was very favorable for observing the eclipse of the sun, which happened on the morning of that day. The following meteorological observations taken every ten minutes during its continuance may be useful for comparison.

Meteorological Observations during the Eclipse, July 18th, 1860, at Philadelphia.

	Thermometer.	Relative Humidity.	Force of Vapor.	Dew Point.	Barometer at 32° F.	Wind.	Clouds.		
							Sky covered.	Course.	Description.
	°	Per ct.	Inch.	°	Inch.	Direc.			
A. M., 6 h. 30 m.	72	62	·486	58·2	29·890	E N E	·3		Stratus, Haze.
40	73	58	·472	57·4	29·900	N E.	·3		“ “
50	73	58	·472	57·4	29·920	N E.	·4		“ “
7 h. 00 m.	74	59	·493	58·6	29·928	N E.	·4		“ “
10	75½	56	·490	58·4	29·948	N E.	·4		“ “
20	75	55	·479	57·8	29·948	N E.	·3		“ “
30	75½	56	·490	58·4	29·938	N N E.	·3		“ “
40	75½	57	·507	59·4	29 937	N E.	·3		“ “
50	76	54	·483	58·0	29·937	N E.	·3		“ “
8 h. 00 m.	76	56	·501	59·0	29 947	N E.	·3		“ “
10	75½	57	·507	59·4	29·945	N E.	·2		Haze.
20	76	58	·518	60·0	29·945	N E.	·4		Cirrus, cir-st., Haze over Sun.
30	76½	58	·530	60·6	29·945	N E.	·4	N W.	“ “ Haze.
40	77	56	·523	60·3	29·945	N E.	·6	WNW	“ “ Cir-cu, Haze.
50	78½	55	·539	61·1	29·945	N E.	·6	N W.	“ “ Haze.
9 h. 00 m.	80	51	·518	60·0	29·945	N E.	·5	WNW	“ “ “
10	81	49	·523	60·2	29·954	N E.	·6	WNW	“ “ “
20	81½	50	·535	60·9	29·962	E N E.	·6	WNW	“ “ “

On the evening of the 20th, the warmest day of the month, about half past nine o'clock, a very extraordinary meteor appeared in the sky. It arose in the north-western part of the heavens, from a cloud which was made visible by the light of the meteor, from 25° to 30° above the horizon. Then an object, apparently about the size of the full moon, and as bright, suddenly starting from the cloud, traversed in an easterly direction the whole extent of the northern sky; sending off what appeared like sparks until it passed very far to the eastward, when it disappeared behind a cloud, at about the same distance from the horizon as that from which it started. The whole flight from west to east occupied a little less than a minute of time. Soon after leaving the edge of the cloud from which it started, it appeared to separate into two parts of similar appearance, the smaller one closely following the larger and appearing as if connected with it by a band of light. Observers differ in regard to the height at which it passed the meridian, though the majority of those with whom I have conversed agree that it must have been at least 10° below the polar star. Its height at the meridian appeared to be very nearly the same as that at which it first appeared, giving the idea of a body moving in the direction of a tangent to the curvature of the earth's surface. It has been supposed from a comparison of observations made at many places, that the path of the meteor was vertical about 110 miles north of Philadelphia, passing over the northern part of Pennsylvania, in a nearly easterly course, over or near the north part of New Jersey, the south-west corner of the State of New York and Long Island Sound. If this supposition is correct, it must have been between 63 and 64 miles above the earth's surface in the meridian of Philadelphia. It pursued its course across the ocean, being seen many miles out at sea, and perhaps passed beyond the influence of the earth and resumed its original character of a wanderer in the planetary spaces. These are the results of our present information in regard to this stranger. Further and more accurate observations may somewhat modify the conclusions arrived at in regard to its precise position in our system.

A Comparison of some of the Meteorological Phenomena of July, 1860, *with those of July,* 1859, *and of the same month for ten years, at Philadelphia.*

	July, 1860.	July, 1859.	July, 10 years.
Thermometer.—Highest, . .	95½°	97°	100½°
“ Lowest, . .	57	54	53
“ Daily oscillation,	19·80	20·20	15·90
“ Mean daily range,	5·00	4·60	3·80
“ Means at 7 A. M.,	72·50	72·00	74·10
“ “ 2 P. M.,	83·89	82 68	83·93
“ “ 9 P. M.,	74·34	73·31	76·78
“ “ for the month,	76·91	76·00	78·27
Barometer.—Highest, . .	29·979 in.	30·212 in.	30·212 in.
“ Lowest, . . .	29·495	29·554	29·443
“ Mean daily range, .	·112	·099	·094
“ Means at 7 A. M., .	29·811	29·870	29·861
“ “ 2 P. M., .	29·774	29·833	29 831
“ “ 9 P. M., .	29·787	29·853	29·846
“ “ for the month,	29·791	29·852	29·846
Force of Vapor.—Means at 7 A. M.,	·539 in.	·551 in.	·618 in.
“ “ “ 2 P. M.,	·505	·574	·618
“ “ “ 9 P. M.,	·559	·579	·645
Relative Humidity.—Means at 7 A. M ,	67 per ct.	69 per ct.	73 per ct.
“ “ “ 2 P. M.,	43	51	53
“ “ ,, 9 P. M.,	65	69	70
Rain, amount in inches, . .	0·851	3·915	3·820
Number of days on which rain fell, .	10	11	10
Prevailing winds, . . .	s.70°1′w. ·135	n.84°6′w. ·166	s.64°17′w ·123

Abstract of Meteorological Observations for June, 1860; made in Philadelphia, Franklin, Indiana, and Armstrong Counties, Pennsylvania, for the Committee on Meteorology of the Franklin Institute.

1860.	Philadelphia.—Lat. 39° 57′ 28″ N. Long. 75° 10′ 28″ W. Height above the sea 50 feet. Prof. J. A. Kirkpatrick, Observer.									Chambersburg, Franklin Co Lat. 39° 58′ N. Long. 77° 45′ W. Height 618 ft. Wm. Heyser, Jr., Obs.							Indiana, Indiana Co. 40° 40′ N. 79° 10′ W. Height, 1321 ft. W. B. Hildebrand, Obs.				Freeport, Armstrong Co. 40° 44′ N. 79° 42′ W. Height. 1000 feet. J. H. Baird, Obs.		
	Barometer.		Thermometer.			Force of vapor.	Relative humidity.	Rain.	Prevail'g winds.	Barom	Thermom.		Force of vapor.	Relative humidity.	Rain.	Prevail'g winds.	Thermom.		Rain.	Prevail'g winds.	Thermometer.		Prevailing winds.
June.	Mean.	Mean daily range.	Mean.	Daily oscillation.	Mean daily range.	2 P.M.	2 P. M.			Mean.	Mean.	Mean daily range.	2 P. M.	2 P. M.			Mean.	Mean daily range.			Mean.	Mean daily range.	
	Inch.	Inch.	°	°	°	Inch.	Per ct	Inches.	Direc.	Inch.	°	°	Inch	Per ct.	Inch.	Direc.	°	°	Inch.	Direc.	°	°	Direc.
1	29·678	·055	67·3	12	5·0	·438	54		N W.	29·109	62·3	7·7	·389	63		S E.	55·3	12·3		N W.	54·0	10·7	(var.)
2	29·735	·063	70·7	21	4·0	·321	32		N W.	29·189	68·0	9·0	·336	37		W.	62·3	7·0		N W.	58·7	6·7	N W.
○ 3	29·691	·051	73·3	21	4·0	·375	37		S W.	29·101	65·7	2·3	·476	59	0·070	W.	59·0	6·7		(var.)	62·7	8·0	?
4	29·457	·234	69·0	16	4·3	·514	59	0·670	S E.	28·772	69·3	4·0	·524	51	0·834	W.	67·0	8·0	0·310	(var)	69·0	7·0	S W.
5	29·287	·170	65·3	11	3·7	·576	84	0·100	S E.	28 648	68·0	4·3	·595	76		W.	63·0	4·7	0.100	S W.	60·7	8·3	N W.
6	29·469	·181	67·7	14	2·3	·520	66	1·460	W.	28·848	70·0	2·0	·505	56		W.	64·0	2·3	0.360	N W.	63·3	2·7	?
7	29·492	·025	71·0	17	3 3	·424	43		N W.	28·855	69·7	2·3	·489	62		W.	65·7	1·7	0.180	W.	65·7	2·3	W.
8	29·499	·032	68·7	19	2·3	·362	37	0·180	W.	28·861	68·3	3·3	·331	39	0·090	W.	58 7	9·0	0.760	N W.	57·0	8·7	W.
9	29·522	·039	63·8	13	4·8	·362	51		N W.	28·944	62·7	5·7	·502	79		W.	53·0	5·7		N W.	52·7	5·0	N W.
10	29·587	·065	66·0	19	2·5	·438	54		N W.	29·011	64·3	2·3	·358	46		W.	58·3	2·7		N.	57·7	5·0	(var.)
☾ 11	29·691	·104	69·0	21	5·0	·235	26		N W.	29·092	66·7	3·7	·305	34		W.	63·7	6·7		N W.	66·0	8·3	W.
12	29 807	·115	73·2	29	4·2	·294	28		N W.	29·167	71·3	4·7	·389	42		W.	71·3	9·0		N W.	70·0	6·7	E.
13	29·836	·037	74·7	25	2·2	·514	46		S W.	29·187	75·3	4·0	·382	37		W.	75·3	5·3		E.	76·0	0·7	S.
14	29·839	·042	75·5	24	0·8	·426	37		S W.	29·212	73·0	2·3	·501	51		E.	76·0	2·7		S E.	69·0	3·7	S.
15	29·835	·033	75·3	21	0·5	·440	39		S W.	29·204	73·3	0·3	·452	44	0·060	E.	74·3	1·7		S W.	72·3	3·3	W.
16	29·833	·008	70·3	17	5·0	·606	70	0·070	W.	29·207	66·3	8·3	·516	84		E.	68·3	6·0	0·380	N.	68·3	4·0	N.
17	29·874	·041	68·0	10	5·3	·562	79	0·325	(var.)	29·236	70·0	6·3	614	68		E.	68·3	6·7		N.	66·0	2·3	E.
18	29·840	·039	70·7	18	5·0	·511	49		S E.	29·223	72·7	2·7	·524	51		E.	72·3	4·0		(var.)	70·7	4·7	?
● 19	29 641	·199	70·2	16	3·8	·611	68	0·570	S S W.	28·974	73·0	1·7	·497	45	0·045	W.	69.7	4·7		S W.	68·3	3·7	W.
20	29·596	·056	72 2	19	3·7	·525	52		N W.	28·978	70·7	4·3	·532	63	0·040	W.	66·7	3·7		W.	66·0	3·0	N.
21	29·828	·231	60·0	13	12·2	·383	66		N E.	29·186	65·0	5·7	·516	84		(var.)	68·3	1·7	0·160	N W.	63·7	2·3	N W.
22	29·929	·102	66·7	18	6·7	·321	41		N E.	29·316	64·3	2·7	·380	56		N E.	67·0	3·3		E.	60·7	3·7	E.
23	29·954	·025	71 8	25	5·2	·410	40		N E.	29·330	70·3	6·0	·470	52		N E.	68·7	6·3		E.	66·0	5·3	?
24	30·082	·127	70·3	21	1·5	·355	36	E N E.		29 473	72·7	3·0	·417	41		E.	74.7	6·0		E.	72·3	6·3	?
☽ 25	30·102	·040	71·8	25	2·2	·375	37		N N E.	29·514	70·0	2·7	·470	52		E.	74 7	0·7		S W.	73·0	2·0	N W.
26	29·978	·124	80·2	29	8·3	·494	35		W.	29·408	76·3	6·3	·650	54		(var.)	75·3	4·0		S W.	76·0	3·0	N W.
27	29·928	·050	80·7	15	7·2	·577	50		N W.	29·338	75·7	6·7	·827	86	0·220	(var)	76·0	6·0		W.	72·3	5·7	W.
28	29·871	·057	80·5	20	5·8	·458	36		(var.)	29·256	79·3	3·7	·637	62		(var.)	76·7	4·7		(var.)	75·3	7·7	W.
29	29·650	·221	82·2	19	3·3	·717	48	0·331	W S W.	29·063	81·7	3·0	·809	59		(var.)	75·3	3·3	0·220	W.	78·0	6·0	S W.
30	29 683	·064	85·3	19	3·8	·776	53		W.	29·154	80·0	3·7	·802	71		S.	74·7	0·7		N W.	74·3	3·7	W.
Means	29·740	·088	71·7	19	4·2	·464	48	3·706	N 67° W	29·104	70·5	4·2	·509	57	1·359	N 82° W	68·1	4·9	2·530	N 65° W	66·7	5·0	N 65° W.

Abstract of Meteorological Observations for June, 1860; made in Adams, Dauphin, Northumberland, Centre, and Somerset Counties, Pennsylvania, for the Committee on Meteorology of the Franklin Institute.

1860.	GETTYSBURG, Adams Co. Lat. 39° 49′ N. Long. 77° 18′ W. Ht. 624 ft. Prof. M. JACOBS, Obs.					HARRISBURG, Dauphin Co. 40°16′, N. 76°50′, W. Ht., 300 ft. JOHN HEISELY, M.D., Obs.					SHAMOKIN, Northumberland. Co. 40° 45′ N. 76° 30′ W. Height, 700 ft. P. FRIEL, Obs.				FLEMING, Centre Co. 40° 55′ N. 77° 53′ W. Ht., 780 feet. S. BRUGGER, Obs.				SOMERSET, Somerset Co. Lat. 40° N. Long. 79° 3′ W. Height 2195 feet. GEO. MOWRY, Observer.						
June.	Barom Mean.	Thermom. Mean.	Thermom. Mean daily range.	Rain.	Pre-vail'g winds.	Barom Mean.	Thermom. Mean.	Thermom. Mean daily range.	Rain.	Pre-vail'g winds.	Thermom. Mean.	Thermom. Mean daily range.	Rain.	Pre-vail'g winds.	Thermom. Mean.	Thermom. Mean daily range.	Rain.	Pre-vail'g winds.	Barom Mean.	Thermom. Mean.	Thermom. Mean daily range.	Force of vapor. 2 P.M.	Relative humidity. 2 P.M.	Rain.	Pre-vail'g winds.
	Inch.	°	°	Inch.	Direc.	Inch.	°	°	Inch.	Direc.	°	°	Inch.	Direc.	°	°	Inch.	Direc.	Inch.	°	°	Inch.	Per ct.	Inch.	Direc.
1	29·336	62·0	8·7	0·010	N W.	29·573	68·3	4·3		N W.	58·7	9·0		(var.)	58·0	7·7	0·085	W.	27·650	52·7	10·3	·355	84	0·024	W.
2	29·446	68·0	9·3		N W.	29·660	72·7	3·7		W.	62·0	8·0		(var.)	67·0	5·7		W.	27·749	58·0	6·0	·384	52		W.
○ 3	29·296	64·3	4·3	0·095	S W.	29 571	70·0	3·3	1·265	W.	60·7	2·0		W.	63·0	4·0		W.	27 577	60·0	4·0	·393	59	0·115	S.
4	28·980	67·0	3 3	1·820	S W.					N E.	62·3	2·3	0·400	(var.)	63·7	1·3	1 735	W.	27·264	65·7	6·3	·650	66	0·546	(var.)
5	28·842	64·0	5·0	0·195	N W.	29·109	69·3			W.	65·0	4·0	1·661	(var.)	64·0	3·7	0·420	(var.)	27·222	60·7	5·0	·443	65	0·299	W.
6	29·065	69·7	5·7	0·040	(var.)	29·327	74·3	5·0	0·420	N W.	67·7	4·3		W.	66 0	3·3		(var.)	27·365	66·0	5·3	·504	56	0·167	W.
7	29·087	69·0	1·3	0·010	N W.	29·324	74·3	1·3	0·113	W.	69·7	2·3		W.	64·0	2·0	0·100	W.	27·406	61·0	5·0	·450	67	0·120	W.
8	29·096	66·0	3·0	0·008	(var.)	29·350	68·7	5·7		W.	61·0	8·7	0·086	W.	62·0	2·0	0·160	N W.	27·428	60 7	0·3	·411	60	0·152	W.
9	29·202	60·3	5·3		N W.	29·426	65·7	3·0		N W.	58 0	5·7		W.	58·3	4·3	0·020	N W.	27·553	50·3	10·3	·375	93	0·193	W.
10	29·227	64·0	3·3		N W.	29·489	68·0	3·0		N W.	60·3	2·3		(var.)	59·3	5·7		N W.	27·616	53·0	4·0	·270	47		N W.
☾ 11	29 339	68·3	4·3		N W.	29·586	71·7	4·3		N.	63·0	12·0		W.	64·0	4·7		N W.	27·673	58·3	6·0	·389	50		(var.)
12	29·412	71·0	2·7		S W.	29·675	75·3	3 7		S W.	67·3	4·7		W.	70·7	6·7		(var.)	27·685	66·0	7 7	·546	52		S E.
13	29·436	72·0	1·7		S.	29·699	77·3	2·0		S.	69·0	3·3		W.	71·0	1·0		(var.)	27·696	67·7	7·0	·549	57		E S E.
14	29·442	72·3	1·0		S S E.	29·713	76·7	0·7		S.	67·7	1·7		W.	72·0	1·7		S W.	27·717	66·7	4·3	·493	49		S E.
15	29·427	72·3	2·0		(var.)	29·689	75·7	1·7	0.142	S.	69·7	2·3	0·070	W.	72·3	2·3		W.	27·704	70·0	3·3	·557	49		S E.
16	29·442	62·0	7·7	0·102	(var.)	29·705	68·7	10·3	0·211	N.	59·7	14·7	0·675	E.	64·0	8·3	1·230	(var.)	27·718	61·3	8·7	·419	68	0·011	S E.
17	29·487	69·3	8·0		N W.						65·3	7·0	0·016	E.	67·3	4·7		W.	27·748	65·7	4·3	·435	48		E N E.
18	29·471	72·3	4·3		(var.)	29·707	74·3			S W.	65·7	1·7		N W.	70·0	2 7		(var.)	27·722	69·7	6·0	·608	46		(var.)
● 19	29·234	70·3	1·7	0·210	S W.	29·476	74·3	4·7	0·132	(var.)	65·3	5·7	1·200	S E.	70·0	4·0	0·340	W.	27·546	67·3	5·0	·520	55	0·397	W.
20	29·205	71·0	3·0	0·109	N W.	29·462	71·7	4·0	0·695	N E.	62·3	6·3		W.	67·0	3·0		W.	27 551	63·3	4·0	·475	58		W.
21	29·423	63·3	7·7	0·065	N E.	29·697	66·7	5·0		N E.	61·7	3.3		S E.	66·0	3·0	0·500	S E.	27 662	64·0	0·7	·531	63	0·240	(var.)
22	29·559	64·0	3·3		N N E.	29·828	68·7	4·7		(var.)	63·0	2·7	0·073	(var.)	62·3	6·3		E.	27·780	57·0	7·0	·406	63		(var.)
23	29·572	70·3	6·3		(var.)	29·837	75·3	6·7		W.	62·3	6·0		W.	68·0	5·7		E.	27·843	62·3	6·0	·401	45		(var.)
24	29·716	71·7	1·3		(var.)	29·996	74·0	1·3		S.	69·0	6·7		W.	70·3	2·3		S E.	27·892	66·7	4·3	·571	52		S E.
☽ 25	29·746	70·3	2·0		(var.)	29·005	74·3	2·3		S.	64·3	4·7		S W.	71·3	2·3		S E.	27·928	71·0	4·3	·677	49		W.
26	29·626	77·7	7·3		S W.	29·863	81·0	6·7		S W.	74·7	10·3		N W.	75·0	3·7		W.	27·905	71·0	2·0	·635	51		W.
27	29·558	76·7	8·3	0·080	(var.)	29·814	80·0	6·3		W.	73·3	9·7		W.	74·3	6·0	0·740	W.	27·832	71·3	6·3	·657	68	0·191	W.
28	29·493	79·0	5·7	0·020	S W.	29·728	83·3	4·7	0·095	W.	75·7	10·7	0·080	(var.)	71·7	4·7	0·350	W.	27·760	75·3	4·7	·854	62	0 263	(var.)
29	29·250	82·3	3·3		WSW	29·508	85·7	5·0		W.	79·0	7·3	0·200	(var.)	75·3	4·3	0·260	W.	27·614	75·3	3·3	·670	58	0·036	W.
30	29·351	81·0	2·0		S W.	29·592	85·7	2·7		W.	76·3	6·7		W.	71·3	4·0		W.	27·662	72·0	3·3	·771	78	0·430	W.
Means	29·359	69·7	4·4	2·764	N79°W	29·694	74·0	4·8	3·073	West.	65·5	5·9	4·461	West.	67·3	4·0	5·940	N87°W	27·649	64·3	5·2	·513	59	3·184	S66°W.

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CIVIL ENGINEERING.

*On the Decay and Preservation of Building Materials.** By Prof. D. T. Ansted, M. A., F. R. S.

(Continued from page 163.)

The question then arises how these things are to be overcome in our climate. Generally speaking, one would be apt to suppose that non-absorbency was a most desirable thing; and that if we could render stones non-absorbent—that is, if we could prevent them from sucking in the moisture and these dangerous gases—we should be able to answer our purpose and prevent the decay of the stone. I need not inform you that it is no new thing to preserve in this way—not, indeed, stone—but other substances, such as stucco and terra cotta. You can scarcely go into a good modern street in London without seeing a large number of houses covered over with cement, and that cement covered over with paint. Now, what is paint? It is a mixture of oil and oxide of lead. The paint coats the surface in such a way that water cannot get into it. We all know the result; the paint, indeed, never looks well; it is not an ornamental thing under ordinary circumstances, and much less so when applied to stones. But how far is it successful? Why, the moment it is put on, it begins to decay. Decay must take place, because oil begins to decompose the moment it is exposed to the action of the air; and the result is, that after a very short time the oil separates from the oxide of lead, and the surface first blackens and soon begins to peel off. You have a thin film of oil and white lead put on a surface; it adheres slightly for a time, but the moment it is left alone it begins to decompose and rot, and in the course of a year or two you must do all the work over again. Numerous plans have been patented for coating and choking the pores of absorbent stones with preparations of various kinds. The almost invariable idea has been, to render the stones as far as possible non-absorbent. This has been done by combining a certain proportion of mineral substance with oil or fatty matters. There is but one observation with regard to these; they all inevitably tend to decomposition except, perhaps, those that are of a pitchy or bituminous nature.

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* From the Journal of the Society of Arts, No. 396.

Bitumen is of a nature that does not decompose by exposure, and is permanent, but it is of so dark and disagreeable a color that it completely destroys the appearance of stone, and renders it so unsightly that no one could venture to recommend it. Oil and fatty substances, therefore, are the only ones that have been used. One cannot help feeling, that if our stone buildings are to be painted till their character as stone is lost, it would be better to build them of cheaper material and use bricks and stucco at once. I may say with regard to the patents that have been taken out within the last 20 years on subjects of this kind, that I have had no less than 17 before me, and out of these 17, 11 are simply mixtures of various substances with oils and resins, and are therefore essentially of the same nature. Some of the others use mixtures of mineral matters in oil, but none of them appear to have answered the purpose, and none of them are now employed at all. There is another point I ought to mention, and that is, that a mere mixture of things not involving chemical combination, must fail. We must then either have some invention by which the pores of stones are permanently choked by a bituminous substance, not unsightly, and not in any way subject to decomposition, or we must find some mineral deposit which we can answer for, which will adhere firmly and which will also be permanent; in other words, we must put something into or upon the stone which shall be a mineral substance, closely adhering and not subject to ordinary atmospheric influences.

It is now many years since a suggestion was made by a French chemist, of the name of Kuhlman, which was apparently very ingenious, and which to a certain extent, answered the purpose. It was a suggestion to coat the surface of absorbent stones with silica. Now, I have already spoken to you of silica as forming the great mass of sandstones, and also, to a great extent, the base of granite. Common flint is the form in which we all know it. In that form it appears to be rather an unpromising suggestion to apply it to a surface in such a way that it shall adhere and be permanent. Silica, which is in fact a combination of a base which is called *silicon* with oxygen, is also called by chemists *silicic acid*, but the acid properties are so weak that they cannot be recognised by the senses, and its affinities for alkaline bases are very feeble. Silicic acid, or silica, is capable of existing in combination with water, and in combination with some alkalies is soluble; is found in nature, combined with water, in some minerals, and when in that state is passed into a state of insolubility by the action of alkaline carbonates, among the rest carbonate of lime.

As a natural hydrate, or combined with a small quantity of water (about 3 or 4 per cent.), it forms part of some particular kinds of sandstone. It is also found in natural hot springs, and even in common spring water,—no doubt by the action of carbonic acid. I have said that it is soluble in caustic alkali. It is soluble, for example, in caustic potash and caustic soda, not under ordinary temperature and pressure, but at a temperature of 300° or 400° F., and under steam pressure. Under these circumstances there is no difficulty in dissolving it. You get a solution in this way: a mixture of silica and potash combined with water, and a tenaceous though soluble fluid. I have a specimen of it before me. You see it is perfectly fluid; it is as much a fluid as water would be; but if in this state you expose it to the action of ordinary air for a time, it hardens, becoming first sticky and gelatinous. It is then a hydrate of silica. To become this it undergoes a certain kind of decomposition, parting with its potash to carbonic acid in the air. Before the lecture, I placed a drop of the fluid solution on a piece of glass, and those who take an interest in it may see what the effect has been. It was perfectly fluid; it is now quite gelatinous and sticky, and in a short time it will become perfectly hard. It has attached itself, also, firmly to the surface of the glass, and could not now be removed. In this form it was proposed to use the liquid silicate of potash, or water glass, by M. Kuhlman, whose process consists in the coating of absorbent stone with the solution in question, and he believed that after this treatment the stone would become coated with silica. Since it is known that silica laid on and dried is insoluble, he believed he had secured a useful result; but he forgot that insoluble silica that has been deposited in that way is still capable of being acted upon by the alkaline carbonates. Therefore, even when thus deposited, still in the course of time the alkaline carbonates of the atmosphere would act upon it, and it would be a failure. But that is not all; for, if at the time I put this drop on the glass I had not taken care that the glass was dry, or if I had dashed water on it, it would have been washed away. Now that is exactly what would happen if you put some of it on a stone, and a shower of rain were to fall. In that case the effect would be destroyed, the preparation being washed away. So much for the process which Kuhlman invented. It is right to say that M. Kuhlman himself believed that when used in limestone a double decomposition would take place, the silicate of potash being not only decomposed by the carbonic acid of the air, but a part of the silicic acid combining with the lime to form silicate of lime. This would, however, be a work of time, which the weather in a damp climate would not permit.

Another process has been introduced by Mr. Ransome. His plan was to decompose the silicate of potash and to produce a deposit of mineral upon it, which would adhere to the stone by a process of double decomposition. He considered that if a mineral deposit could be absorbed into the stone, I mean if, after a solution was absorbed into the stone, it could afterwards, by a chemical combination caused by another solution subsequently absorbed, be decomposed so that a solid film would be everywhere deposited, and if this could be done in a very brief space of time, so that damp air, and rain should have no effect upon it, then the object required would be attained. It suggested itself to him in this way:—He was in the habit of manufacturing the soluble silicate on a large scale, and he thought that by combining it with the chloride of calcium (muriate of lime) he would get this double decomposition. This is the case, because soda and potash have but a weak affinity for silica, and lime a very strong one. Silica, therefore, parts very readily indeed with soda or potash to lime, whilst the chlorine would, with great readiness, pass to the soda. He therefore attempted the process; and I think you will say he attempted it with some success, at any rate so far as the experiment went. There is, however, no obscurity about the general result, as it is simply a matter of experiment. The first thing he did was to satisfy himself that he could get a rapid deposit. In the two glasses before me, one contains a certain proportion of silicate, and the other contains a corresponding proportion of the chloride of calcium, so that the two shall combine and form solids. In mixing these together, I put the chloride of calcium into the silicate of soda. The result is, that the affinity of the chlorine for sodium being greater than that for calcium, while the affinity of the silica for soda is weak, a double decomposition takes place, the chlorine leaving the calcium to pass to the sodium, thereby forming soluble chloride of sodium, or common salt, and the silica and lime set free, also combine to form silicate of lime, an insoluble salt, which is immediately thrown down in a solid state. The proportions being properly taken, the whole of the water is taken up and made use of as water of solidification, and the salt can be subsequently removed by washing.

[The lecturer, while performing the experiment, stated that by the time the lecture was over the whole of the contents of the glasses then liquid would be in a solid state, and added, that unless it was removed before long, the solid silicate of lime formed would adhere to the glass so firmly that it would be very difficult to get it off.]

We thus have silicate of lime rapidly formed, and being obtained in this way it is necessary to consider what the result would be in the solution of the problem before us. I need not say it is by no means sufficient to have an insoluble mineral deposit placed on the surface of a mineral whether calcareous or silicious. It is not only necessary to have that, since there must also be cohesion, and this cohesion must be sufficiently powerful to render the mineral coating preservative. It is absolutely necessary that the silicate of lime should be a material which, when put on a surface of stone, should not only remain there, but become permanently adherent. Experience, however, has long ago shown that a very thin deposit of this peculiar mineral, silicate of lime, does adhere with singular rapidity, and with the most remarkable tenacity, to particles of sand and stone with which it comes in contact. It is the film which, produced gradually, gives all its value to mortar, and which cements together the stones of which are formed what builders call concrete, on the very existence of which as a firm solid mass, half our buildings depend. Immediately on the deposit of the minute particles produced by the double decomposition of two minerals and formation of two others, this strong tendency to adhere comes into operation. The particles of silicate of lime newly set free, immediately and firmly attach themselves to the particles or grains of which the stone is made up, not only surrounding them, but binding them to each other, just as when mortar has long been left to harden it is as difficult to separate the parts cemented as it is the solid brick or stone; this it is which gives its principle value to the method suggested.

I have laid on the table several specimens of different materials which have been treated in this way, and also some of the results after they have been exposed to decomposing agencies. Near me are two specimens of terra cotta. One has not been treated in any way, and it is exceedingly absorbent, and we know from experience that terra cotta soon becomes injured on exposure to the weather. The other has been treated by the processes that I have mentioned, and if any one will take the trouble to scratch the surface, he will at once see the nature of the change. The surface has become excessively hard, and although when treated this way it is not necessarily non-absorbent, it can be made so by repeating the process often enough. If not made non-absorbent, however, it has become less capable of injury by exposure. These specimens were prepared at the Museum at South Kensington.

There is also before me a specimen of Heddington stone exposed to Ransome's process, and another specimen of the same stone not exposed to that process. Both of them have been dipped in acid, and the result is as you see. The surface of one is entirely gone; the surface of the other is not touched. There are also two specimens of Caen stone, one exposed to the process and the other not. Both have been subjected to the same amount of acid, and the result is that one stone is entirely destroyed and the other is not injured. There are several other specimens of Mr. Ransome's stones on the table, and the hardness of them will be at once recognised by any one who will compare them with similar stones not so treated.

There is another process which I ought to mention, which has been partly carried into operation in the Houses of Parliament. It was introduced by a Hungarian gentleman, of the name of Szerelmey.* I can hardly with propriety say any thing about it. I know too much and too little about it to be able to express an opinion. At the same time, if I did not mention it, it might seem as if I had not been aware of it. Mr. Szerelmey, at the suggestion, I believe, of the late Sir Charles Barry, asked me to look at his process, but he did not inform me what its preservative power consisted of, and although he intimated its nature, he evidently intended me to regard what I observed as confidential. All I can say is, that regarding it as a secret process, it is quite impossible for any one to express an unqualified opinion of its value until time shall have tested its capabilities. It is, therefore, best not to speak of it at all until it has been exposed for a number of years to the action of the weather. Time alone can show what its value is, if the materials employed are not stated, and certainly an experience of not less than several years can be regarded as of any value, since ordinary paint or drying oil will preserve absorbent stones for that period.

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* Since the lecture was delivered a correspondence has been printed by order of the House of Commons which renders some further observations desirable:—Mr. Szerelmey had not, I now find, allowed me to ascertain the real nature of the method he adopted, which consists in the use of soluble alkaline silicates, succeeded by a wash of bituminous matter also in solution. This was stated in confidence to Dr. Faraday, who, however, does not say that the application of the soluble silicates is succeeded by a second wash producing a deposit of silicate of lime. We are led to infer that the second wash is the bitumen only, and the object of this must be to shelter the surface while the alkaline silicate is undergoing slow decomposition and becoming converted either into hydrate of silica or silicate of lime, just as by Kuhlman's method. It would thus appear to be Kuhlman's process with the addition of a bituminous and temporary sheltering surface. It still remains to determine whether by this process permanent protection is given, as if the deposit consists of hydrate of silica, the alkaline carbonates to which it must soon be exposed will no doubt destroy it. The temporary shelter of bitumen cannot be taken into account as having permanent value, although, for the time it lasts, it may, no doubt, appear to be more efficacious than any thing else. I observe that Dr. Faraday, in expressing a qualified opinion on the present appearance of the stone thus acted on, speaks "of the short and insufficient evidence now existing." It is indeed clear that the real value of the method of Kuhlman depends on the nature of the deposit formed, and I believe it has not yet been determined what this is, simply because there has not been time enough given for the experiment. Complete exposure of a surface protected by Mr. Szerelmey left without any subsequent treatment for some years (four at least), could alone decide the question. The condition of the Speaker's Court, in the Houses of Parliament, will thus after a time be a fair test of the value of his method.—D. T. ANSTED.—26th May, 1860.

In returning now to the original subject, let me remind you that if, as seems to be the case, we are forced to make use of soft, perishable material for purposes of decorative work in architecture, if we are obliged to accept the material that nature has provided near at hand, and select from varieties which differ indeed much in durability but all of which decay, it would seem only reasonable that due precaution should be observed to take for the best work the most favorable varieties of stone, and use great caution in rejecting manifestly bad or indifferently good samples. That this can be done every quarry-man and every stone-mason well knows, and there are means of determining the good from the bad which are independent of their experience. Where enormous sums are to be expended on decorations for a permanent building, it is surely not unreasonable to expect and require that a little niggardly economy in regard to the material of construction should not be indulged in. But I regret to say that in most modern public buildings it has not been thought necessary either to determine the kind of stone with reference to its probable durability, or to appoint a competent person to reject on the spot bad samples. With regard to our architects, it seems hardly to be a part of their education to inquire into and understand such matters, and they do not consider themselves responsible ultimately for the consequences of neglect. I have endeavored to show what must happen when bad stones are placed in a building erected in or very near a large town. The whole of the stone decays, but the more prominent and the more ornamental parts, those on which the effect most depends, and on which most money has been spent, these decay first. Moisture is absorbed, frost comes, and the delicate projecting parts fall. Gases and acids are absorbed together with smoke, and the stone is first blackened and disintegrated, and then reduced to powder. But of course there are bad and good pieces; there are exposed places and sheltered places, and the result of this is that not only does the stone decay, but it decays with the utmost irregularity: adjacent stones become very soon in a state so different that no one could have supposed they were dug from the same quarry, and the whole surface is unsightly and disfigured.

None of the nobleness and beauty of decay is seen in these cases. There is a decent and picturesque appearance, not unfrequently met with, in old buildings which inspires respect instead of dislike. There is the hoary front of age, of which none can complain. It is seen in the marbles of Greece and Asia Minor, in the limestones of Rome, and even in some of the porphyries in Egypt. Time, we are told, devours all things. All human contrivances must submit to it, and as it is a natural, so it is often a beautiful condition. But premature decay, like an artificial ruin, has a poor and mean appearance. It does not give the idea of waning strength, but of absolute innate weakness. It is a *coup manqué*—a thing not merely imperfect, but unnecessarily imperfect.

It is important to remark also that bad stone was not always used. Many of our old buildings have scarcely shown incipient decay—many of those in large towns have decayed so as not to be unsightly. This, it is true, must not be altogether attributed to the material, as such buildings, if erected now with picked stone from the same quarries, would probably injure much sooner, owing to the much larger quantity of impurity in the atmosphere to which they are exposed. When a stone has been for some time exposed to pure air it hardens, and thus buildings, placed where we see them before the large town arose around them, have stood exposure better than they could do now. But there is reason to know that the selection of stone was much more careful formerly than it has been lately, and the result is manifest.

There is one more point. If the method of protection and preservation so ingeniously contrived by Mr. Ransome is successful, as it really seems to be, the softer and cheaper stones may be used. It is certainly the case that a hard, almost flinty surface is obtained by it, and that such surface is not acted upon by the acids which rapidly destroy the same stone when unprotected. For four winters stones thus protected have stood the action of the weather, and if it turn out to be as durable as seems likely, from this and other trials on a large scale, if absorption is checked—so far at least as its injurious effects are concerned—for mere absorption does not seem to be injurious, and if decay is thus arrested, then there are means at hand which cannot fail to have a great influence on decorative stone-work, for the material most easily carved and sculptured is just that one which is most completely improved by the process.

In thus speaking of the decay and preservation of stone, I have endeavored to confine myself strictly to the subject before me, not traveling out of the record. I feel, however, so convinced of its importance that I offer no apology for bringing it before you, and, perhaps, when in your summer ramblings you visit some noble cathedral, or wander over the ruins of some ancient castle or tower of classical or middle age construction, you may feel an interest in examining the cause of the beauty you there see arising from decay, and contrast it with the dissatisfaction and disappointment I am sure you cannot help feeling on examining some of the recent restorations of Westminster Abbey, or the richly decorated surface of the great palace of the nation immediately adjacent.

*Abstract of a Paper on Steam Boilers.** By F. H. Sawyer.

The author, after pointing out the main features of the different varieties of steam boilers, proceeded to a more minute consideration of the marine, as being, in his opinion, the most important. In describing the flue boiler, he remarked that it was quite impossible to give a very accurate account of the proportions of heating surface to fire-grate, &c., as one pair of engines might exert only their nominal horse power, whilst another pair might exert four or five times as much. The author argued the great superiority of the multitubular, as compared with flue boilers, founding his preference on the fact that a boiler of the former kind might be applied with a reduction of sometimes one-third the space, and even a greater proportion of weight, and at the same time giving a greater heating surface per horse power. In exemplification of this he gave the particulars of the original flue boilers of the *Great Western* steam ship, and compared them with the new boilers of the tubular principle, afterwards substituted; the results being as follows:

	Old Boiler.	New Boiler.
Weight with water, . .	280 tons.	108 tons.
Heating surface per H.P., .	9·6 sq. feet.	17·8 sq. feet.
Area of fire-grate, per H.P.,	.5 "	·36 "
Consumption of coal, per H.P. per hour,	8·33 lbs.	5·6 lbs.

The author was of opinion that, by the application of a blast in the funnel, a greater quantity of fuel might be burnt per square foot of fire-bar, and that, therefore, a boiler of smaller dimensions would be attainable; remarking, at the same time, that he considered that, in some cases, the space thus saved would counterbalance the space and value of the extra fuel used. The author then proceeded to discuss the adoption of a higher pressure of steam, together with the principle of surface condensation, noticing that we could not hope for a successful result by jumping at once from 20 lbs. to 50 lbs. per square inch, but he had no doubt that the advantages of a higher pressure would be seen, and that we should see it gradually increasing in the same manner as it had increased from 4 lbs. to 20 lbs., showing a corresponding reduction in the consumption of fuel. He did not expect to see the economy reduced so low as was said to be the case in the *Thetis;* and although he had no doubt but that considerable economy had been attained in that vessel, at the same time he was not prepared to admit or credit the very wonderful economy said to have been realized.

After giving the dimensions and particulars of the tubular boilers of the *Queen* steamer, constructed by Messrs. Rennie, and noticing them as an advantageous description of boiler, the author proceeded to discuss the advisability of brick or iron fire bridges, giving his decided preference to the brick, from the ease with which they can be altered or removed, and also from the fact that the iron bridges so soon wear out, owing to the difficulty the steam has in escaping from the interior, and their great liability to corrosion from the water that might escape from the tubes.

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*From the Lond. Engineer, No. 220.

In a boiler of good proportions he considered there should be no priming, but should any take place owing to dirtiness of water, passing from fresh water in salt, or *vice versa*, he recommended the use of tallow, or as a preferable expedient, if circumstances permitted, opening the fire-doors and slackening the fires. He considered, also, that some trouble might be caused by priming in small high-pressure marine boilers, unless great care was exercised.

The author devoted but a small portion of his paper to the consideration of the stationary and locomotive boilers, but occupied some of his remaining time in discussing the relative economy of the Cornish and locomotive boilers, considering the Cornish greatly superior, as in a locomotive the temperature in the smoke-box was notoriously greater than the temperature at the base of the chimney in a Cornish boiler, and that the heat passed up the funnel was a dead loss, except that which was necessary to keep up the draft.

The author concluded by giving the dimensions and mode of construction of one of Stephenson's 12 in. locomotive engines, as also that of Crampton's colossal engine, the Liverpool.—*Proc. Civ. and Mech. Eng. Soc.*

*The Decay of Timber and its Prevention.** By H. LETHEBY, M.B., M.A., &c., Professor of Chemistry in the College of the London Hospital.

SIR:—I regret that I was not able to be present at the Society of Arts, on the 30th May, during the reading of Mr. Burnell's very valuable paper on the causes of decay in building woods, and the means of preventing it; for, as I have directed much attention to the subject, and especially to the *modus operandi* of creosote, or dead oil, in preserving timber, I should have taken part in the discussion.

Mr. Burnell does not attach too much importance to the process of creosoting timber, when he regards it as the most effective of all the processes known for the prevention of decay; for, in truth, the dead oil of common coal-tar contains all the elements which are necessary for giving permanent stability to organic compounds, by checking decomposition, by opposing the processes of oxidation, and by destroying the vitality of the lower forms of animal and vegetable life. If, indeed, the application of creosote to timber has ever failed in preventing decay, it has been because of the improper use of it, or the use of an oil which has not contained a due proportion of its most effective constituent—carbolic acid. This it is which is chiefly concerned in strengthening the weak affinities of the young or immature constituents of wood. It coagulates the albumen and gives firmness to the cellulose matters that are so prone to decay, and which communicate by a sort of catalytic influence, their decomposition to the neighboring and more mature tissues. So powerful is the antiseptic property of this acid that, when separated from coal tar, it will at once arrest the decomposition of every kind of organic matter. I have seen it stop the putrefactive changes of sewage and cess-pool matter instantly, and it will even stay the more active decomposition of putrefying animal flesh. It is to be regretted that all samples of dead oil do not contain a like proportion of this valuable constituent. I have found that it ranges from 0·05 per cent. to rather more than 6 per cent. of the oil; and as the value of the oil is dependent on the proportion of this acid, it is a matter of some importance to know how its presence can be discovered. A rough estimate may easily be made by shaking up about half a pint of dead oil with its own bulk of a rather weak solution of caustic potash. After standing for a little while, the oil will separate, and the potash solution of the carbolic acid may be poured off. On acidulating this with sulphuric acid, the carbolic acid will separate, like an oil, and it may be known by its creosote-like odor.

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* From the Journal of the Society of Arts, No. 395.

Another important constituent of dead oil is the hydro-carbon, which gradually discolors the oil and thickens it by absorbing atmospheric oxygen and forming a solid pitch. This operates in preserving wood by appropriating the oxygen which may be within its pores, and so checking ligneous eremacausis. The resinoid body which is formed shuts up the pores of the wood and effectually protects it from the action of air and moisture. The presence of this hydro-carbon may be known by the darkening, and, as it were, drying of the oil when it is put upon white filter paper and exposed to the air. In the distillation of the oil this compound comes over most freely at the time when naphthaline distils; and as far as my experiments have gone, I am led to think that the best dead oil (that charged with most carbolic acid, and the resinafiable hydro-carbon) comes over at from 360° to 490° Fahr. The carbolic acid is most abundant in the runnings at or near to the first temperature, and the media for holding them in solution and applying them to the timber at the last. Naphthaline, and paranaphthaline, or salts, as they are sometimes termed, will of course come over at these temperatures; but as these substances are of no value whatever in preserving timber, they should be separated as far as possible by submitting the oil to cold and to the action of time. Dead oil should not be exposed to the air more than is necessary, in order that oxygen may not be absorbed and the oil thickened and discolored. Lastly, I may say that carbolic acid and the hydro-carbons of dead oil are among the most powerful poisons to fungi, and acori, and all the lower forms of organic life. The oil, therefore, acts as a physiological preservative of timber. In point of fact its preservative action is of four kinds:

1. It coagulates albuminous substances, and gives stability to the constituents of the cambium and cellulose of the young wood.
2. It absorbs and appropriates the oxygen which is within the pores of the wood, and so checks, or rather prevents, the eremacausis of the ligneous tissue.
3. It resinifies within the pores of the wood, and in this way shuts out both air and moisture.
4. It acts as a positive poison to the lower forms of animal and vegetable life, and so protects the wood from the attacks of fungi, acori, and other parasites.

No doubt the action of the oil is injurious to higher forms of animal life. It is even offensive to ourselves, and hence the objection to its use in the interior of buildings. But I am led to think that this objection may be overcome by the use of agents, which, like nitric acid in its action on the benzole of the lighter oil of coal tar, may give to the dead oil a less offensive, if not a positively pleasant odor. When this is accomplished there can be no objection to its use in the interior of buildings, or for the preservation of ships.

*Description of a Steam Crane.** By Mr. J. Campbell Evans, of Greenwich.

The steam crane described in the present paper was designed more especially for use on board steam vessels; and the chief points to be aimed at were consequently compactness, facility of fixing, simplicity in the mode of working, and durability. In cranes usually constructed, the boiler being separate from the engine, the union joints of the steam pipe are very liable to leak; and the writer believes there are very few such cranes where this circumstance has not been a continual source of trouble and annoyance after a few months' regular work. Frequently the boiler is a considerable distance away from the cylinder, and then the steam and feed pipes are liable to be injured in stowing the cargo; in addition to which, the condensed steam strains the machinery, and keeps the deck of the vessel constantly wet and dirty.

To obviate these disadvantages, in the present steam crane, the boiler is placed as close as possible to the crane, and revolves with it; and by making the top of the boiler of cast iron, with lugs for attaching the tension rods, it serves the double purpose of boiler and crane post. The bed-plate upon which the crane and boiler are placed is fixed to the foundation-plate by a centre bolt, which bears all the upward strain; the downward pressure is taken by rollers, having their bearings in the bed-plate, and running on the foundation-plate, which is solidly bedded on timber laid on the deck of the vessel.

To avoid upright tubes and horizontal tube plates, the heating surface of the boiler is arranged in cones; the first cone or fire-box is exposed to the direct radiation of the fire, after which the heat passes through an opening nearly opposite the fire door into an annular space between the second and third cones, where it is absorbed by the water spaces on either side, and passes round to the funnel opposite. In this way a sufficient heating surface is obtained without any horizontal surfaces in the boiler for deposit to accumulate upon. The two angles or bottoms of the water spaces are below the direct action of the fire, and are connected by pipes to allow for the circulation of the water, provided with plugs and cocks for cleaning. The water tank is placed under the boiler; this position serving to heat the feed water and to preserve the cast iron bed-plate from danger of fracture by the heat of the fire.

The crane is worked by a single oscillating cylinder, supported by brackets on the bed-plate. The joints for the steam and exhaust pipes at the trunnions are made tight by gun-metal cones, fitted to the trunnions and held by studs in the brackets; when these have become polished by working, the wear upon them is very slight, and this construction has been found very suitable for the rough treatment to which cranes are usually subject. On the crank shaft is a friction wheel, grooved according to Mr. Robertson's plan, and kept continually revolving by the engine. On the second shaft is another friction wheel, which, by means of a lever, can be moved into gear with the driving wheel, or, by an opposite motion of the lever, can be pressed against a brake, or when lowering can be held between the two. The other end of the second shaft carries pinions gearing into wheels on the shaft of the chain barrel. There are two pairs of wheels and pinions, for varying the speed according to the weight to be raised; the pinions are thrown in and out of gear by a sliding key, instead of the ordinary clutch; by which means, the width between the frames that would be required for moving the ordinary clutch is saved.

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* From Newton's London Journal, August, 1860.

The writer believes the principal difficulty experienced in steam cranes for ship purposes is in the arrangement of the turning gear; so that when the vessel leans over to one side, the crane shall be powerful enough to swing the weight, and yet not cause a sudden start or shock to break the gear. In this crane, a coned friction clutch is used, to allow a slip at first and to start the weight gradually; and the arrangement of the foundation-plate of the crane admits of a much larger spur-wheel than usual being employed to bring up the power. On the crank shaft is a worm working into a worm wheel, on the shaft of which is a bevil wheel, gearing into the two bevil wheels above and below, which are thus kept constantly revolving by the engine. By means of a coned clutch acting on one or other of these wheels, the crane can be moved round either way, as desired. The two operations of lifting and turning the weight are easily managed by one man.

The valve motion of the oscillating cylinder is designed to compensate for the oscillation of the cylinder without the use of sweeps and guides. A radius rod is centred on the cylinder bracket, and connected to the eccentric rod by a link, to which the valve rod is attached by a pin. The link combines the vibrations of the eccentric rod and radius rod, so that at the point where the valve rod is attached, the curve described by the radius rod compensates for that described by the eccentric rod in such a degree as to bring the valve rod into the curve it would naturally be made to describe by the oscillation of the cylinder.

Mr. Evans observed that the crane was intended as a machine of simple construction, complete in itself, including boiler, for fixing in such situations as on decks of vessels or on quays, where generally the expense of larger stationary boilers for working a number of separate steam cranes could not be gone to. These cranes had worked very satisfactorily, the only wear, after more than a year's work, being in the bearing of the crank shaft, and by tightening up the nuts of the cap one-eighth of a turn, all the wear of some months was taken up.

There was an advantage in the leverage in turning round, and the crane was found very convenient for handling; the grooved friction wheels, for connecting and disconnecting the motions, had proved very satisfactory, and worked smoothly and efficiently.

Mr. H. Maudslay inquired what pressure of steam was used, and what weight could be easily lifted by the crane; and what was the cost of the whole.

Mr. Evans replied, that 30 to 40 lbs. steam was used, and the crane lifted 50 cwts.; a larger size was being constructed to lift 50 cwts. 42 feet high in half a minute. The cost of the cranes at present made was about £200 complete; no pipes were required for connexion to the boiler as in detached steam cranes, and no fixings were wanted for the crane or boiler; all that was required was to lay down 4-inch timbers to bed the frame upon, and it was a particular advantage in the case of ships that no holes were required in the deck for the crane post, the whole being self-contained.

Mr. E. A. Cowper thought it was a disadvantage in the arrangement that the steam must be shut off directly the load was off to prevent the engine running away; and a single cylinder had this disadvantage—that it might stop on the centre, causing a delay in starting the crane again. He thought it was preferable, for working a crane, to have two cylinders working cranks at right angles and with link motion, as in Taylor's steam winch; the engines were then started or reversed readily, in whatever position they might have been stopped, and there was a decided advantage in thus getting rid of the fly-wheel.

Mr. Evans replied, this difficulty of a single cylinder was completely met in the present crane by having a small hole remaining open when the steam was shut off, which allowed steam still to pass just sufficient to keep the engine constantly moving at a slow speed, and turning only the first of the friction wheels. A double-cylinder crane would involve greater cost and complication, and a good deal of knocking was liable to occur in the gearing of a quick working crane on that plan; there was also the objection of water accumulating in the cylinders when standing, which was avoided by having the engine always moving.

Mr. H. Maudslay thought it a good idea to put the boiler at the back end to balance the jib, which made an advantageous arrangement. In a 30-ton steam crane recently erected in the wharf at Messrs. Maudslay, Son & Field's works, the engine was fixed upon the jib, consisting of a pair of small cylinders, with short stroke, working cranks at right angles; the crane lifted 30 tons and the lowering and raising were done very smoothly by the cylinders; for lowering such a weight double cylinders were of course wanted, to prevent a jerk.—*Proc. Inst. Mech. Engineers.*

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*On Road Locomotives.** By the Earl of CAITHNESS.

My present object is not to enter into any detailed history of the steam engine from its commencement, or to trace its gradual improvement, but to place before you as briefly as possible some of the advantages that may accrue from it as a means of transit on our common roads.

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* From the London Civ. Eng. and Arch. Jour., August, 1860.

The public mind is usually set against any thing new. When steamers were first spoken of they were looked on as a most wild and dangerous expedient. They would be constantly on fire,—would not, or could not go to sea,—and if they did, who would be found mad enough to go with them? Mr. Miller, of Dalswinton, found this to the cost of mind and person; and Mr. Bell, though more successful with his first boat on the Clyde, had his battle to fight against public opinion. Railways at first were looked on as wild and visionary, and dangerous in the extreme to Her Majesty's subjects. Thanks to George Stephenson, his perseverance had its reward, not only to himself, but in a much larger degree to us.

My object is to lay before you what in my opinion may some day work nearly as great a benefit on society as our railways. The subject is not new, but I am not aware that it has ever been brought before the British Association. It is road locomotion by steam. It seems the more important at this time to discuss the subject, as at present a bill is before parliament to enact certain tolls on locomotives; and so much fear is expressed by various parties as to the freedom from danger of these machines, that I think it a favorable opportunity to bring the subject before the meeting. Various plans have been tried, and vast sums of money expended, in endeavoring to perfect a good road locomotive. Watt designed one to carry two persons, but it was not constructed, his other employment taking up so much time as to prevent him carrying it out. The first actual steam carriage we read of was made by a Frenchman named Cugnot, who showed it to Marshal Saxe in 1763. He afterwards made one that, when first set in motion, went through a wall, and being by this means or other violent exhibition of its powers considered very dangerous, was placed in the Arsenal Museum at Paris, where it now is. An American, Oliver Evans, also invented a steam carriage in 1772, but it did not come into use. William Symington conceived the same idea for Scotland, but the roads were then so bad, that, to speak in a slang way, it was "no go;" this was in 1786. The next inventor was William Murdoch, who in 1784 made a model of a steam carriage, which is still in possession of a relative of Murdoch's. Another inventor of steam carriages was Thomas Allen, of London, who in 1789 designed one to carry goods and passengers.

The most successful, however, seems to have been a locomotive built by Richard Trevethick, of Cornwall, and Andrew Vivian, his cousin, (Trevethick was a pupil of William Murdoch.) He took out a patent for it in 1802. His carriage was like a common stage-coach. It had only one cylinder. This was the first successful engine made to work with high-pressure, moving the piston both ways against the pressure of the atmosphere only. The first road steam-carriage was, on the whole, wonderfully successful. It caused great excitement in his neighborhood. This carriage safely reached London, and was publicly exhibited on an inclosed piece of ground where Euston-station now stands.

Having thus shown that in the early days of steam, carriages were made and driven on common roads, I am about to bring the subject before this meeting, in the hope if it is now taken up, and backed by the British Association, we shall have this most useful, and now well understood power, brought to bear as a most efficient means of conveying heavy goods and passengers, as tenders to our railways, instead of making so many short branches of railways that do not pay.

Mr. Scott Russell, many years ago, made a successful steam carriage that ran between Glasgow and Paisley; and if it had not been for a most unfortunate misunderstanding between the promoters of the carriage and the road trustees, whereby a fatal accident took place, I believe it would then have made a great stride in the right direction. It performed its journey very well for some time.

One of the great reasons why we may now look for success in road locomotives is, that instead of as formerly having a heavy machine or carriage worked with a comparatively light pressure of steam, we now have a light carriage and worked at a heavy pressure. We now have the means of making very strong boilers very light, and to stand a high pressure.

A number of plans have been tried, all more or less successful. The first one that came out of late was Mr. Boydell's, with its endless railway attached to its wheels. This carriage, though I have not seen it at work, has, I understand, drawn great weights after it at a cost much less than that of horse-power; and though clumsy in appearance, yet that may be got over. The first thing in my mind is to establish the actual working of this mode of hauling.

We have now another and also a most successful steam carriage in Mr. Bray's. It is very ingenious. It has now been working for some time with perfect success; and though it was unfortunately transmogrified last year into a green dragon, and for a time gave in, yet there is no reason why it should not turn out a most useful machine. Indeed it has proved itself so a great many times within a few months, in taking large loads through London. It has drawn over thirty tons through the most crowded thoroughfares of London, and in no instance has any accident occurred during its employment. The economy in its use has been equal to a saving of one-half the cost of employing horse-power.

Mr. McConnell, to whom the world is largely indebted for very valuable improvements in the locomotive engine, has, I believe, undertaken to give his able attention to this subject, with a view to bring out a simpler engine than that now in use. This I feel can be done with ease, so as to make a much more workable and less costly machine. I think great speed should not be looked for in traction engines. What is wanted, in my opinion, is a means of taking large loads at a small cost. It is a great mistake to suppose that injury is done to the road by the use of steam carriages. The truth is that there is much less injury done than by using horses,—the broad wheels acting like rollers, and so rather improving than hurting the road.

The Marquis of Stafford has had a small steam carriage in use now for two years, and it works with great ease. It was made by Mr. Rickett, of Castle Foundry, Buckingham. Since it was made Mr.

Rickett has made two others, introducing great improvements, being direct acting instead of being driven by a pitch chain. One of these carriages has been built for myself. It weighs one ton and a half, and I have had a speed of nearly twenty miles an hour out of it. I gave a suggestion as to the mode of placing the axle in connexion with the driving gear, which I will explain. I placed the axle of the road wheel in radial segments, so that the springs rise and fall by the action of the road, the driving gear or toothed wheels are never allowed to be at a greater distance from each other at any time; the axle as it rises or falls performing a part of a revolution round a crank shaft, on which is fixed the smaller wheel which gives the action to the road wheels. Its action is perfect, as the teeth of the wheels are always in gear to the same depth; and the consequence is that the springs act most perfectly, and it goes along the road without trouble. I have now had several trips on it from Buckingham to Wolverton, a distance of ten miles, and this has been done within the hour including stoppages.

Another advantage of steam on roads over horse-power is, that instead of requiring twenty or thirty horses, forming quite a troop, to take a carriage containing some heavy weight, you place before the said carriage a steam engine. This power will cost but a small sum in comparison with horses; it will be a constant power so long as it gets coal and water. It will take up but little room, not being much larger than a common carriage. This seems a most important reason for the advancement of steam, as at this present day saving of time, money, space, and at the same time gaining increase of power, are cogent reasons for advocating any cause.—*Proc. Brit. Assoc.*, 1860.

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*Horse Railways on Common Roads.** By John Crane.

To the Editors of the Mechanics' Magazine:—

Gentlemen:—Perfectly agreeing with yourselves and Messrs. Train & Burn in the advantages to be derived from horse railways, I humbly crave a corner in your able and liberal Magazine for a brief exposition of my own views on a mere matter of debateable detail. It strikes me that there is no need whatever for the vehicles that run on rails in public streets to have flanched wheels, which would prevent their running except on such rails; but that the present wheels might be retained, provided all the axletrees were made the same length, and a form of rail adopted like that in Fig. 1. It may be called a "trough rail," and is five inches wide inside, with two flanches, and to be fixed on continuous longitudinal wooden sleepers, or embedded in stone blocks laid down at intervals of about four feet. I also recommend a stone curb to be laid along each side of the rail, such as is now generally used for curbing

Fig. 1.

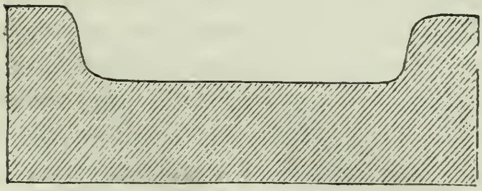
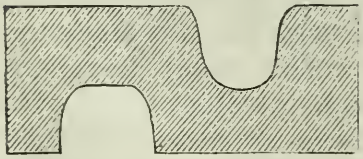


Fig. 2.



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*From the Lond. Mechanics' Magazine, June, 1860.

foot-paths. But if a flanched wheel be preferred, then I think the form of the rail in Fig. 2 is better suited to meet the various requirements of the case than any I have yet seen. Each could be made either of wrought or cast iron, and of course of any dimensions to suit the particular traffic. I will not now take up any more of your space or your readers' time by enlarging on the advantage of my proposed plans, but conclude by assuring you that—whether they are novel or not—I shall not patent them, but present them to the public gratuitously.

39 Lee Crescent, Birmingham, May 31, 1860.

For the Journal of the Franklin Institute.

New Rule for Depths of Keystone for either Segmental or Elliptic Arches of Stone. By JOHN C. TRAUTWINE, C.E., Philada.

I submit the following original rule for determining the depth of keystone for either segmental or elliptic arches of stone, as coinciding more nearly than any other with which I am acquainted, with the practice of the best engineers:

For first class cut-stone work of hard material take ·36 of the square root of the radius at the crown. For second class work ·4; and for brick or rubble arches ·45 of the same square root.

The following examples will show the accordance of the rule with existing structures both elliptic and segmental, in the first case, viz: with first class work and materials.

$$\cdot 36\sqrt{\text{Radius at crown.}}$$

	Span in feet.	Rise in feet.	Rad. at Crown in feet.	Actual Key in feet.	Calcul'd Key in feet.	Engineer.
Cabin John Aqueduct and Roadway Arch of the Washington Aqueduct,* .	220	57¼	134¼	4·16	4·17	Meigs.
Grosvenor Bridge, across the Dee, .	200	42	140	4·00	4·26	Harrison.
London Bridge (new). Thames, .	152	29½	162	4·75	4·58	Rennie.
Gloucester Bridge, Severn, .	150	35	150	4·50	4·41	Telford.
Claix Bridge, France, . .	150	54	82	3·10	3·26	
Dora, Turin, . .	148	18	160	4·80	4·55	Mosca.
Neuilly, as designed, . .	128	32	160	5·30	4·55	Perronet.
Neuilly, as it exists on account of the settlement of the arches, . .	128		250	5·30	5·69	Perronet.
Licking Aqueduct, Ches. and Ohio Canal,	90	15	76	2·83	3·14	Fisk.
Staines Bridge, . .	74	9·3	78 —	3·00 —	3·18	Rennie.
Bow Bridge, England, .	66	13·75	81	2·50	3·24	Walker and Burges.
Monocacy Aqueduct, . .	54	9	50·0	2·50	2·55	Fisk.
Lugar Viaduct, Scotland, .	50	25·00	25·0	2·00	1·80	Miller.
James River Aqueduct, . .	50	7	47·0	2·66	2·47	Ellet.
Reading Railroad, at Reading, .	31	5	26·8	1·66	1·86	Steele.
Semi-circle, . . .	2·0	1·00	1·0		0·33	
Pont Napoleon Viaduct, Paris, small rubble masonry in cement: multiply by ·45.	115·5	14·75	120	4·00	4·93	Couche.
Maidenhead Viaduct, brick in cement; multiply by ·45 . .	128	24·25	169·0	5·25	5·85	Brunel.

Our public works abound with cut-stone arches having keys varying from ·36 to ·4 of the square root of the radius of the crown, and with rubble arches having keys from ·4 to ·45 of the same square root; but I have not thought it necessary to introduce them.

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*This is the largest stone arch of modern times, or, *perhaps*, of any former period, unless we except the ancient bridge of Trezzo, *said to have been* 251 feet span; it was designed, and its erection superintended by Capt. Montgomery C. Meigs, of the U. S. Topog. Engineers.

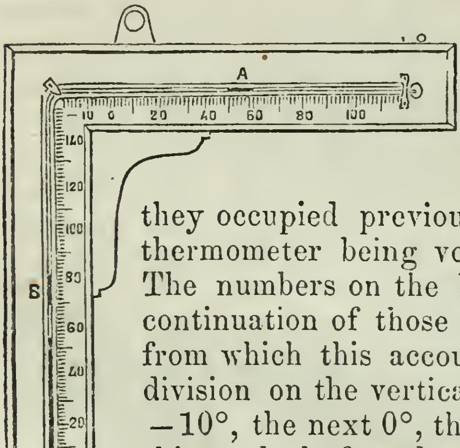
MECHANICS, PHYSICS, AND CHEMISTRY.

*Hicks' Maximum and Minimum Mercurial Thermometer.**

The following description of a new maximum and minimum mercurial thermometer invented by Mr. James Hicks, was written by Balfour Stewart, Esq., and communicated to the Royal Society by J. P. Gassiot, Esq.:—

About a fortnight since, Mr. James Hicks, the intelligent foreman of Mr. L. P. Casella, optician, called at Kew Observatory with an instrument of the accompanying description, for the purpose of having it compared with the ordinary maximum and minimum thermometers. This comparison proving very satisfactory, and the principle of the instrument commending itself to Dr. Robinson, Mr. Gassiot, Professor Walker, and several other scientific men who examined it, Mr. Gassiot requested me to write a short description of it, which he thought might be of interest to the Royal Society. For many particulars of this description I am indebted to Mr. Casella, and Mr. Hicks, who furnished me with details regarding the construction of the instrument.

Its chief advantage consists in its furnishing us with a mercurial minimum thermometer, no serviceable instrument of this description having hitherto been made. At the same time it is also capable of being used as a mercurial maximum thermometer.



The principle of the instrument is briefly as follows:—It has a cylindrical bulb nearly three and a half inches long and half an inch in diameter, filled with mercury. This gives a bore nearly $\frac{1}{20}$th of an inch wide, and a scale on which 1° Fahrenheit corresponds to about $\frac{1}{20}$th of an inch, when the graduation has reached 150° F. or so; both the tube and the scale are made to assume a position at right angles to that which they occupied previously, so that the first portion of the thermometer being vertical, the second will be horizontal. The numbers on the horizontal scale are not, however, in continuation of those on the vertical, for in the instrument from which this account is taken, while 150° is the highest division on the vertical scale, the first on the horizontal is −10°, the next 0°, the third 10°, and so on. The reason of this method of graduation will immediately appear. Above the mercury there is a small quantity of spirits of wine, which extends some distance into the horizontal tube. The quantity of this, and the graduation, correspond in such manner that the extreme end of the spirit column denotes the same degree of temperature as the mercury. The remainder of the horizontal tube is filled with air. There are two movable indices in the spirit column, one in the vertical tube, the other in the horizontal, each about half an inch long. The former, B, consists of a fine steel magnet inclosed in glass. This forms the body of the index. At either extremity there is a head of black glass, similar to that which occurs in the index of an ordinary minimum themometer. A fine hair is tied round the neck of this index, between the body and the upper head; and it is made to hang down by the side so that by its elastic pressure against the tube the index may be kept in its place notwithstanding its verticality. The index in the horizontal tube A is in all respects similar to that of an ordinary maximum thermometer.

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* From the Mechanics' Magazine, June, 1860.

Let us now suppose the instrument fixed in its position, the first part of the stem being vertical. In order to adjust it we must first bring the vertical index into contact with the upper extremity of the mercurial column. To do this, let us take two small but strong horseshoe magnets, and lay the one above the other, so that the poles of the one shall overlap to a small extent the corresponding poles of the other. Bring the magnets up to the index in such a manner that, while the poles of the one bear against the side of the glass tube, the overlapping poles shall lie over the tube so as to be in front of the index; the index will now follow the motion of the magnets, and it may thus be brought down to the surface of the mercury. In order to bring the horizontal index to the extremity of the spirit column, all that is necessary is to incline the horizontal tube a little downwards by pressing on the end. The indices being now set and the instrument in adjustment, let us suppose the temperature to rise—the mercurial column will push the vertical index up, but this index will remain in its place when the mercury again falls, and will, therefore, denote the maximum temperature reached. On the other hand, let us suppose the temperature to fall—the mercury in falling is followed by the spirit column propelled by the air behind it. The spirit column again will, on its edge coming in contact with the end of the horizontal index, draw the index with it into a position, where it will remain when the mercury again rises. This index will, therefore, register the extreme minimum point which the spirit column has reached; but by the principle of graduation this will correspond with the minimum point reached by the mercurial column.

Let us now suppose that a small portion of the spirit column has become separated, and lodged itself in the extremity of the tube. The principle of graduation will immediately enable us to discover this by a want of correspondence being produced in the reading of the mercurial and of the spirit columns. If, for instance, before the separation the mercury read 50°, and the horizontal extremity of the spirit column also 50°, it is clear that, after the abstraction of spirits has taken place, the horizontal column will read lower. We have thus a check upon this possible source of error, which we have not in the ordinary minimum thermometer. Indeed, it is to all intents a mercurial minimum thermometer that we are now describing, the spirits serving merely as a vehicle for the indices. It will be remarked that were both columns capable of acting in a horizontal position, there would be no necessity for the bend, and the instrument would be more portable; but in this position it is found there is danger of the spirits becoming mixed with the mercury, and thus interfering with the action of the instrument. Should this ever be brought about by traveling, or any cause, a smart jerk or two of the instrument will join the separated columns and put all right.

The instrument is thus constructed:—The vertical tube, including the bulb, is first made and filled with mercury to the proper height, and the magnetic index is introduced; then the horizontal tube is joined, and the spirits of wine and the horizontal index are introduced. The bulb is then placed in a freezing mixture, in order that the mercury may retreat as far as possible, followed by the spirits of wine. The tube is then sealed, care being taken that the bore shall end in a small rounded chamber; for, if pointed, some of the spirits would be apt to lodge there, whence it would be difficult to remove it. The object of cooling the bulb before sealing off is, that we may have as much air in the tube as possible, for its pressure, as already mentioned, enables the spirits to follow the mercury when the latter falls.

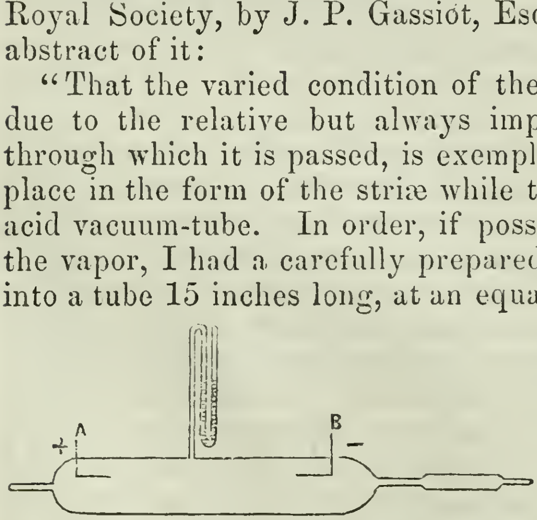
To graduate the instrument, set it with the mercurial stem horizontal in melting ice, then point off the extremity of the mercurial, and also of the spirit column as corresponding to 32° F. Perform a similar operation in water 42°, 52°, 62°, &c., and also in freezing mixtures down to zero, or lower if necessary.

In conclusion, if used as a wet-bulb thermometer, this instrument will give us the maximum and minimum temperatures of evaporation obtained under precisely the same circumstances.

*On Indications of Vacua.**

An interesting paper "On Vacua as Indicated by the Mercurial Siphon-gauge and the Electrical Discharge" was recently read at the Royal Society, by J. P. Gassiot, Esq., F. R. S. The following is an abstract of it:

"That the varied condition of the stratified electrical discharge is due to the relative but always imperfect condition of the vacuum through which it is passed, is exemplified by the changes which take place in the form of the striæ while the potash is heated in a carbonic acid vacuum-tube. In order, if possible, to measure the pressure of the vapor, I had a carefully prepared siphon mercurial gauge sealed into a tube 15 inches long, at an equal distance between the two wires A B. This tube was charged with carbonic acid in the manner described by me in a former communication. When exhausted by the air-pump and sealed, it showed a pressure indicated by about 0·5 inch difference in the level of the mercury; the potash was then heated; the mercury gradually fell until it became perfectly level. Dr. Andrews (*Philosophical Magazine*, February, 1852,) has shown that with a concentrated solution of caustic potassa, he obtained



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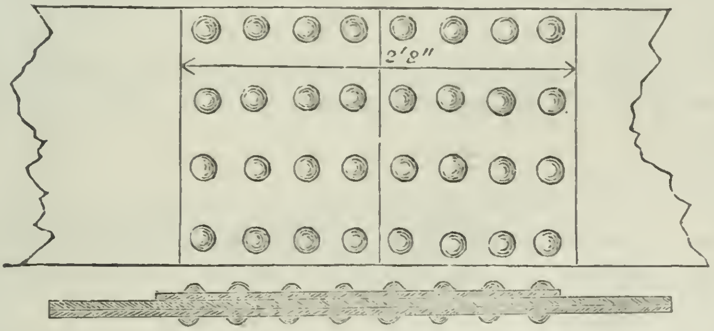
*From the London Mechanics' Magazine, June, 1860.

with carbonic acid a vacuum with the air pump so perfect as to exercise no appreciable tension, as no difference in the level of the mercury in the siphon-gauge could be detected. On trying the discharge in the vacuum-tube after the potash had cooled, I found it gave the cloud-like stratifications, with a slight reddish tinge; consequently not only was the vacuum not perfect, as denoted by the form of stratifications, but in this tube the color denotes that even a trace of the air remains, probably that portion in the narrow part of the siphon-gauge, which, from its position, was not displaced by the carbonic acid."

"The potash was subsequently heated until the discharge was reduced to a wave line, with very narrow striæ; in this state moisture is seen adhering to the sides of the tube; but even in this state the difference in the level of the mercury in the gauge did not ever vary more than ·05 inch. As the potash cooled, the discharge altered through all the well-known phases of the striæ, the mercury again becoming quite level. At first almost the slightest heat applied to the potash alters the form of the stratifications; as the heating is repeated, longer application is necessary; but it shows how sensibly the electrical discharge denotes the perfection of a vacuum, which cannot be detected by the ordinary method of mercurial siphon-gauge.

*Chain Riveting.** By W. Fairbairn, Esq., LL.D., F.R.S., &c., &c.

In the formation of the bottom of a tubular girder, whether composed of cells, as in the Britannia and Conway bridges, or of double plates, as in smaller examples, it is of importance to have as few joints as possible. Hence the plates should be rolled as long as their weight and thickness will allow, and the joints be carefully united by covering plates, *chain riveted*, as shown in the following sketch, with three or more rows of rivets, according to the width of the plates. Eight rivets are required in each of the lines, four on each side of the joint, to give sufficient strength, and the area of the rivets collectively should be equal to the area of the jointed plates, taken transversely through one line of the rivets, the area of the parts punched out in that line being deducted. These proportions give the required security to the joint, and afford nearly the same strength to a tensile strain as the solid plate; that is, if the covering plates be as much thicker as will give the same area of section through the rivet holes as the imperfo-



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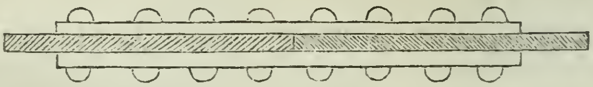
* From the Lond. Mechanics' Magazine, June, 1860.

rated double plate. These precautions being taken in covering the joints of the plates and in securing the angle irons which unite the sides with the bottom, it will meet in practice all the requirements of a uniform power of resistance to strain from one end of the girder to the other.

In a long experimental inquiry which I undertook some years since, it was shown that there was a loss in the riveted joint, as compared with the solid plate, of 30 to 50 per cent.; that is, taking the strength of the solid plate at 100, that of the double riveted joint would be 70, and that of the single riveted joint 50.

This great deficiency in the strength of joints subjected to a transverse strain, caused considerable difficulty in designing the Britannia and Conway bridges; double, treble, and quadruple riveting was thought of; but one after another was abandoned, on account of the rivet holes weakening the plates; and I should almost have despaired of attaining the object in view, but for the system of longitudinal or chain riveting having occurred to me, after repeated trials of other modes and forms. Experiment, however, established the perfect security of this method, as the following tables clearly demonstrate. Two distinct methods were tried, one with a single thickness of plates, the joint having a covering strip on each side; the other with two thicknesses of plate, there being a joint in one of them covered by a plate, and kept in position by a line of rivets as already described. The jointed plates having been prepared, the experiments were effected by a powerful lever, tearing the joints and plates asunder in the direction of the line of rivets.

Chain Riveting. Single Plates, with double Covers over the Joint.

No. of Experiment.	Weight in lbs.	Elongation in inches.	REMARKS.
1	5,600		Weight of the lever.
2	26,656		
3	28,448		
4	30,240	·021	
5	32,032	·034	
6	33,824	·034	
7	35,626	·044	
8	37,418	·052	
9	39,210	·056	
10	41,002		Torn asunder through a rivet hole after sustaining the load a few seconds.

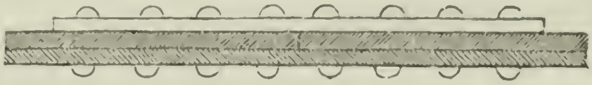
			Sq. in.
Area of section through solid plate,	. .	3·5×·25	=·875
Area of the covering plates,	. .	3·5×·26	=·910
Area of section through rivet hole,	. .	3·0×·25	=·750

Diameter of the rivets, each ½ inch, four on each side of the joint.

If we take the area of the plate at the point of fracture = ·750 inch, it will be found that it required a power of 24·41 or nearly 24½ tons per square inch to tear it asunder.

From the following experiment, it appears that the fracture took place through the solid plate on one side, and by shearing off the rivets on the other. Hence the area of section of fracture $=\cdot875\times\cdot785=$ 1·66 inches, and proceeding as before, we have 18·73 tons per square inch as the breaking weight.

Chain Riveting. Double Plates, and a single Cover over the Joints.

No. of Experiment.	Weight in lbs.	Elongation in inches.	REMARKS.
1	5,600		Weight of the lever.
2	26,656	·016	
3	37,408	·025	
4	46,368	·028	
5	55,328	·075	
6	62,496	·100	
7	69,664		Broke by shearing off the rivets close to the plate.

		Sq. in.
Area of section through plates, . .	2×·875	=1·750
Area of section through rivet holes, . . .		=1·5
Area of covering plate through rivet holes, . .		=0 91

Rivets as before, ½-inch diameter.

Finding the resisting powers of the rivets unequal to the strength of the double plates, they were afterwards increased from half an inch to five-eighths of an inch in diameter, or until the area of the rivets approached nearly to the area of the plates, which gave the required strength. In joints of this description it will be found that the resisting powers of the rivets is nearly equal to that of the plates, *i.e.*, the resisting power of the rivet is to that of the plates as their sectional areas respectively. This is an agreement with the following laws, which have been deduced from experiment:—1st, that the ultimate resistance to shearing, in any bolt or rivet, is proportional to the sectional area of the bar torn asunder; and, 2d, that the ultimate resistance of any bar to a shearing strain is nearly the same as the ultimate resistance of the same bar to a direct longitudinal strain.

For the Journal of the Franklin Institute.

Particulars of the Steamer Zouave.

Hull built by John Engles. Machinery by Morgan Iron Works, New York. Owners, Sandford's Independent Line, New York to Philadelphia.

HULL.—Length on deck, 220 ft. Breadth of beam (molded), 30 ft. 8 ins. Depth of hold to spar deck, 12 ft. 3 ins. Frames, molded, 14 ins.,—sided, 6 ins.,—24 ins. apart from centres, and strapped with diagonal and double laid braces, 4×½ in. One independent steam fire and bilge pump. One bulkhead. Promenade deck with saloon, cabin, and state-rooms. Draft of water forward and aft, 6 ft. 6 ins. Area of immersed section at load draft of 6 ft. 6 ins., 175 sq. ft. Masts, two—Rig, Schooner. Tonnage, 800 tons.

ENGINES.—Vertical beam. Diameter of cylinder, 50 ins. Length of stroke, 11 ft. Cut-off, one-half.

Boiler—One—Return flued. Length of boiler, 27 ft. Breadth of do., (front) 13 ft. Height of do. exclusive of steam chimney, 11 ft. 3 ins. Number of furnaces, two. Breadth of do., 5 ft. 9½ ins. Length of grate bars, 7 ft. 6 ins. Number of flues, below, ten—2 of 22½, and 4 each of 15 and 17 ins.—above, twenty—10 each of 8½ and 9½ ins. Length of flues, above, 20 ft. 8 ins., below, 14 ft. Diameter of smoke pipe, 52 ins.

Paddle Wheels—Diameter over-boards, 31 ft. Length of blades, 7 ft. Depth of do., 24 ins. Number of do., 27.

Date of trial, November, 1860. C. H. H.

For the Journal of the Franklin Institute.

Particulars of the U. S. Steamer Seminole.

Hull built by United States Government. Machinery by Morgan Iron Works, New York.

Hull.—Length at load line, 200 ft. Breadth of beam (molded), 28 ft. Depth of hold to spar deck, 14 ft. Length of engine room, coal bunkers, &c., 48 ft. Two bulkheads. One independent steam fire and bilge pump. Draft of water forward and aft, 10 ft. Tonnage, 755 tons. Area of immersed section at load draft of 10 ft., 264 sq. ft. Capacity of coal bunkers, 220 tons. Masts, three—Rig, Bark. Speed in knots, 9.

Engines.—Two, horizontal steeple. Diameter of cylinders, two of 50 ins. Length of stroke, 2 ft. 6 ins. Maximum pressure of steam, 50 lbs. Cut-off, one-half. Maximum revolutions at above pressure, 80.

Boilers—Two, and one donkey. Vertical tubular. Length of boilers, 22 ft. Breadth of do., 10 ft. 6 ins. Height of do. exclusive of steam chimney, 10 ft. 3 ins. Number of furnaces. 12. Breadth of do., 3 ft. Length of grate bars, 5 ft. 6 ins. Number of tubes, 3685. Internal diameter do., 2 ins. Length do., 2 ft. 7¼ ins. Diameter of smoke pipe, 6 ft. Height of do., 42 ft.

Propeller.—Diameter of screw, 9 ft. 6 ins. Pitch of do., 18 ft. Number of blades, two.

Date of trial, May, 1860. C. H. H.

For the Journal of the Franklin Institute.

Particulars of the Steamer New Brunswick.

Hull built by John Engles. Machinery by Morgan Iron Works, New York. Owners, International Steam-ship Company. Intended service, Portland to St. Johns, N. B.

Hull.—Length on deck, 224 ft. Breadth of beam (molded), 30 ft. 8 ins. Depth of hold to spar deck, 12 ft. Frames—molded, 14 ins.—sided, 6 ins.—apart at centres, 24 ins. and strapped with diagonal and double laid braces, 4×½ in. Independent steam fire and bilge pumps. Promenade deck with saloon, cabin, and state-rooms. One bulkhead. Draft of water, forward and aft, 6 ft. 6 ins. Tonnage, 815 tons. Area of immersed section at draft of 6 ft. 6 ins., 175 sq. ft. Masts, two—Rig, Schooner.

Engine.—Vertical beam. Diameter of cylinder, 48 ins. Length of stroke, 11 ft. Cut-off, variable.

Boiler—One—Return flued. Length of boiler, 26 ft. 2 ins. Breadth, front, 13 ft. Height, exclusive of steam chimney, 11 ft. 6½ ins. Number of furnaces, two. Breadth do., 5 ft. 9½ ins. Length of grate bars, 7 ft. 6 ins. Number of flues, above, 6, below, 10. Internal diameter of flues, above, 1 ft. 5 ins., below, 2 of 22½ ins., and four each of

15 and 17 ins. Length of flues, above, 18 feet 6½ ins., below, 13 feet 2 ins. Diameter of smoke pipe, 4 feet 4 ins.

PADDLE WHEELS.—Diameter, over boards, 31 feet. Length of blades, 7 feet. Depth do., 22 ins. Number do., 27.

Date of trial, October, 1860. C. H. H.

Translated for the Journal of the Franklin Institute.

On the Elastic Force of Vapors. By M. V. REGNAULT.

"I presented to the Academy, in August, 1854, the principal results of the experiments which I had made to determine the laws which exist between the elastic forces of vapors and the temperatures to which they are subjected. This work is a portion of a long series of investigations, the first part of which was published in 1845,* the principal object of which is to collect the physical elements necessary to calcuate the theoretical work which can be obtained from a substance, either when it is transformed into an elastic fluid by means of a known quantity of heat, or when the elastic fluid, losing a certain quantity of heat, develops a known moving power, either in resuming the liquid state as in the condensing steam engine, or simply in increasing in volume, as occurs in high pressure steam engines and in hot-air engines.

"The law which connects the elastic forces of gases and vapors with their temperature necessarily plays an important part in this general question. Moreover, it appears that it ought to be one of the simplest of the theory of heat, because it depends only upon two elements which are clearly defined and susceptible of precise determination, the temperatures and the pressures which the elastic forces balance.

"This announcement will explain the interest which I attached to an investigation of this sort, and the perseverance with which I colected its elements. In fact, my work extends from gases which have been liquefied by compression, to substances, such as mercury and sulphur, whose boiling-points are not so high but that they may be kept in ebullition, under high pressures, in apparatus which can now be constructed.

"The Memoir which includes the whole of these observations has been printed for several years; it forms a part of vol. xxvi, of the Memoirs of the Academy. The publication has been delayed by circumstances beyond my control, and particularly by the necessity of myself tracing upon the plate, as I did for steam (*Memoirs of the Academy*, vol. xxi,) the points determined by each separate experiment, and the curves which exhibit their connexion.

"This Memoir, as I announced in 1854 (*Comptes Rendus*, vol. xxxix, pp. 301, 345, 397), is divided into five parts :

"1st. The first includes my examinations into the elastic forces of saturated vapors through a great range of temperatures.

"2d. The second treats of the elastic forces of vapors emitted by saline solutions, and of their boiling-point under different pressures.

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* See Journ. Frank. Inst., present series, vols. xv, xvi, and xvii.

"3d. In the third, I study the elastic forces of these same vapors in the air and in other gases.

"4th. The fourth treats of the elastic forces of vapors from two volatile liquids, either dissolved in one another, or simply superposed when they exercise no mutual dissolving action.

"5th. Finally, in the fifth, I endeavor to determine whether the solid or liquid state of the same body exercises any influence for the same temperature over the elastic force of the vapor which it emits.

"I shall not here again allude to the last four parts of the Memoir; the general conclusions which I thought could be drawn from my experiments appear to be sufficiently expressed in the *Comptes Rendus* of 1854. I ask of the Academy only the permission to give it some developments of the first part, that which treats of the elastic forces of saturated vapors *in vacuo*, of which I could cite but a few examples in my communication in 1854.

"The various apparatus which I used in these researches are described in the Memoir; I shall not dwell upon them; remarking only that they are referable to two different methods.

"The first, which I call the *statical method*, consists in determining the pressure which equilibriates the elastic force of the vapor, *at rest*, which a liquid in excess emits at various temperatures. In the second method, which I call the *dynamical method*, the vapor is always in motion, and we determine the temperature of the vapor which the liquid *continually* emits when boiling under different pressures.

"These two methods give results which are identical:

"1st. When the liquid is perfectly homogeneous. It is not so when it is impure; the presence of the smallest quantity of a volatile foreign body shows itself immediately by the non-superposition of the two graphical curves belonging to the two methods.

"2d. When the liquid has not a great molecular attraction. In the opposite case the liquid boils intermittently with violent starts, and the determinations by the dynamical method become very uncertain.

"The two methods could be successfully applied to the greater part of the volatile substances which were submitted to my experiments, and they have enabled me to determine their elastic forces from the lowest temperatures up to those which correspond to pressures of from 12 to 15 atmospheres. The greatest part of the gases liquified by pressure give liquids which possess great molecular attraction and resist ebullition notwithstanding their extreme mobility. Their elastic forces can only be certainly determined by the statical method. When we wish to apply the dynamic method, the thermometer cannot be placed in the vapor of the boiling liquid unless the boiling-point is above the temperature of the surrounding air; for if it be inferior, the vapor may become overheated, and the indications of the thermometer will be wrong. If the thermometer is placed in the boiling liquid, it does not show a constant temperature during ebullition, although the pressure remains the same. The indications of the thermometer change much according to the manner in which the heat is applied. The boiling is not continuous; it takes place with violent ıocks, which are attended by a sharp noise like that of the water- ımmer when it is suddenly inverted. These effects vary much with ıe pressure under which the boiling takes place. Certain liquids pre- 'nt them even under pressures below that of the atmosphere; in :hers they appear only under high pressures.

"The limits to which I am obliged to confine myself in this *résumé*, ɔ not allow me to state the individual observations which I have made ı each substance, nor even to explain the method of graphical con- ruction, nor the formulæ of interpolation by which I endeavored to ‹press the results of my experiments in the best way. I will remark ıly, that of all the modes of interpolation which were successively ied, the formula by exponential series, proposed by De Prony and ɔplied by M. Biot, to the vapor of water under the form

$$\text{Log. } F = a + b\alpha^t + c\beta^t$$

the one which applied most exactly to all the substances studied. his formula has, besides the advantage of containing five constants, r the determination of which, five points of the graphic curve, hav- g equidistant abscissæ, may be selected, so that the curve represent- l by the formulæ can vary but very little from the curve traced ırough the intermediate points. Moreover, I show in my Memoir ıat for a great number of the substances studied, we may, by a con- ɜnient adjustment of the fixed points which serve to calculate the ɔnstants, without sensibly departing from the data of direct observa- ɔn, calculate a formula with two exponentials

$$\text{Log. } F = a + b\alpha^t + c\beta^t,$$

which the term $c\beta^t$ introduces only quantities less than the errors ' observation, so that it may be reduced to the more simple one,

$$\text{Log. } F = a + b\alpha^t.$$

"This consideration and the great resemblance which the curves aced for the different substances have to each other, when the ordi- ıte is taken equal to $\frac{F}{760}$, leads me to think that the law of the astic forces and temperatures would present itself under a very simple rm, if for the variable independent we should assume not the tem- ɜrature as we define it in an entirely arbitrary manner, but another ement which should be immediately connected with the constitution ' each body, and whose origin should be fixed for each one of them.

"I have in the following tables presented the elastic forces of the fferent vapors, calculated for temperatures varying by 5°, according the formulæ which I calculated from my experiments. The tem- ɜratures are those of the mercurial thermometer which I used. In y Memoir, I also give the corresponding temperatures taken by the r thermometer. The reduction of the temperatures from the mer- ırial to the air thermometer was determined by especial experiments.

TABLE No. 1.

LIQUIDS OF MEAN VOLATILITY. BOILING-POINT BETWEEN 14° AND 150° CENT.

	ALCOHOL.	ETHER.	SULPHURET OF CARBON.	CHLOROFORM	BENZINE.	CHLORIDE OF CARBON. $C_2\ Cl_8$.
T.	F.	F.	F.	F.	F.	F.
°	mm.	mm.	mm.	mm.	mm.	mm.
— 25					2,37	
— 20	3.34	67,49	43,48		4,94	
— 15	4,69	87,89	60,91		8,62	
— 10	6,58	113,35	81,01		13,36	
— 5	9,21	144,82	104.40		19,30	
0	12,83	183,34	131,98		26,62	30,55
+ 5	17,73	230,11	164,53		35,60	40,09
10	24,30	286,40	203,00		46,59	52,08
15	33,02	353,62	248,40		60,02	67,09
20	44,48	433,26	301,78	160,47	76,34	85,49
25	59,35	526,93	364.24	199,40	96,09	107,94
30	78,49	636,33	436,97	245,91	119,89	135,12
35	102,87	763,27	521,36	301,13	148,37	167,73
40	133,64	909,59	616,99	366,20	182,27	206,51
45	172,14	1077,22	729,72	442,37	222,37	252,31
50	219,88	1271,12	856,71	530,96	269,51	305,39
55	278,61	1484,59	1000,87	633,36	324,61	367,68
60	350,26	1728,52	1163,73	751,01	388,62	439,66
65	436,99	2002,13	1346,86	885,41	462,57	522,26
70	541,21	2307,81	1551,84	1038,09	547,51	616,48
75	665,52	2647,75	1780.28	1210,62	644,59	723,29
80	812,76	3024,41	2033,77	1404,57	756,63	843,70
85	985,97	3440,30	2313,90	1621,52	879,55	978,71
90	1188,43	3898,05	2622,23	1863,12	1019,96	1129,04
95	1423,52	4400,55	2960,30	2130,90	1177,10	1296,47
100	1694,92	4950,81	3329,54	2426,52	1352,27	1481,19
105	2006,34	5552,18	3731,37	2751,23	1546,59	1684,45
110	2361,63	6208,37	4167,18	3106,83	1761,29	1907,21
115	2764,74	6923,55	4638,14	3494,69	1997,48	2150,47
120	3219,68	7702,20	5145,43	3916,17	2256,26	2415,23
125	3730,41		5690,08	4372,73	2538,66	2702,54
130	4301,04		6273,03	4865,65	2845,66	3013,49
135	4935,40		6895,06	5396,23	3178,18	3349,28
140	5637,00		7556,88	5965,76	3537,05	3711,23
145	6410,62			6575,41	3923,00	4100,81
150	7258.73			7226,49	4336,70	4519,73
155	8185,02			7920,19	4778,69	4969,97
160				8657,72	5249,43	5453,88
165				9440,40	5749,26	5974,28
170					6278,40	6534,58
175					6837,04	7138,90
180					7425,66	7792,33
185					8042,41	8501,02
190						9272,67
195						10116,74

TABLE No. 1 (Continued).

LIQUIDS OF MEAN VOLATILITY. BOILING-POINT BETWEEN 14° AND 150° CENT.

	CHLORHYDRIC ETHER.	BROMHYDRIC ETHER.	IODOHYDRIC ETHER.	METHYLIC ALCOHOL.	ACETONE.
T.	F.	F.	F.	F.	F.
°	mm.	mm.	mm.	mm.	mm.
— 30	110,24				
— 25	145,01				
— 20	187,55			6,27	
— 15	239,60			9,29	
— 10	302,09			13,47	
— 5	376,72			19,17	
0	465,18		41.95	26,82	
+ 5	569,32		54,14	36,89	
10	691,11		69.20	50,13	
15	832,56		87,64	67,11	
20	996,23	380,30	110,02	88,67	197,89
25	1184,17	463.30	136,95	115,99	226,27
30	1398,99	559,81	169.07	149,99	281,00
35	1643.24	671,31	207,09	192,01	345,15
40	1619,58	799,35	251,73	243,51	420,15
45	2230,71	945,56	303,77	306.13	507,52
50	2579,40	1111,65	364,00	381.68	602.86
55	2668,43	1299,41	433,21	472,20	725,95
60	3400,54	1510.69	512,25	579,93	860,48
65	3878,52	1747,43		707,33	1014 32
70	4405.03	2011.57		857,10	1189,38
75	4982,72	2305,24		1032,14	1387,62
80	5614,11	2630.45		1238.47	1611,05
85	6301,61	2989,38		1470.92	1861,81
90	7047,51	3384,22		1741.67	2141,66
95	7853,92	3817,11		2051,71	2452,81
100	8722,76	4290,33		2405.15	2797,27
105		4806,11		2806,27	3177,00
110		5366.67		3259.60	3593,96
115		5974,26		3769,80	4050,02
120		6631,08		4341,77	4546,86
125		7339,33		4980,55	5086,25
130		8101,15		5691,30	5669,72
135		8918,64		6479,32	6298,68
140		9793,86		7337,10	6974,43
145				8308.87	
150				9361,35	

TABLE No. 2.

Liquids Boiling above 150° Cent.

ESSENCE OF TURPENTINE.		ESSENCE OF LEMON.		METHYLOXALIC ETHER.	
T.	F.	T.	F.	T.	F.
°	mm.	°	mm.	°	mm.
0	2,07	98,99	69,80	109,41	117,26
10	2,94	115,40	129,39	109,53	117,46
20	4,45	115,10	129,09	125,98	222,67
30	6,87	124,85	178,31	126,06	222,87
40	10,80	125,03	179,01	136,45	320,11
50	16,98	137,00	263,42	145,14	423,37
60	26,46	147,35	357,04	155,70	591,36
70	40,64	155,52	449.23	164,30	761,35
80	61,30	165,08	576,50	188,92	1589,81
90	90,61	174,25	748.67	192,37	1589,81
100	131,11	174,16	749,69	217,16	2958,68
110	185,62	201,60	1439,68	228,95	3875.95
120	257,21	223,30	2328,04	237,16	4849,72
130	348,98	236,65	3213,49	164,48	763,48
140	464,02	239,70	4374,42	242,86	4867,83
150	605,20			253,53	6203,14
155	686,37				
160	775,09				
165	871,27				
170	975,42				
175	1090,11				
180	1207,92				
185	1336,45				
190	1473,24				
195	1618,26				
200	1771,47				
The experiments on the essence of turpentine were carried to much heavier pressures, but I judged it useless to transcribe them here, because they had reference only to an essence completely modified in its molecular constitution. I have in my Memoir described the series of researches by which I studied the isomeric modifications which the essence successively undergoes by its boiling under various pressures.		When these experiments were ended, the essence of lemon showed the same boiling-point at atmospheric pressure as before, but it had completely lost its power of rotating polarized light.		The boiling of methyloxalic ether is pretty steady under pressures but little above that of the atmosphere, but under heavy pressures it becomes very irregular, and produces violent starts.	

TABLE No. 3.

	MERCURY.
T.	F.
°	mm.
0,0	0,0200
10	0,0268
20	0,0372
30	0,0530
40	0.0767
50	0,1120
60	0,1643
70	0,2110
80	0,3528
90	0,5142
100	0,7455
110	1,0734
120	1,5341
130	2.1752
140	3,0592
150	4,2664
160	5,9002
170	8,0912
180	11,00
190	14,84
200	19,90
210	26,35
220	34,70
230	45,35
240	58,82
250	75.75
260	96,73
270	123,01
280	155,17
290	194,46
300	242,15
310	299,69
320	368,73
330	450,91
340	548,35
350	663,18
360	797,74
370	954,65
380	1136,65
390	1346,71
400	1587,96
410	1863,73
420	2177,53
430	2533,01
440	2933,99
450	3384,35
460	3888,14
470	4449,45
480	5072,43
490	5761,32
500	6520,25
510	7353.44
520	8264,96

Note to Table 3.

"The temperatures here recorded are those of the air-thermometer. The boiling of the mercury is pretty steady under pressures below that of the atmosphere. At the atmospheric pressure the starts begin; they become more and more violent as the pressures augment, and under the pressure of 10 atmospheres the shocks are so strong as to produce a noise as loud as that of a forge-hammer striking upon the anvil. The apparatus appeared in danger of flying in pieces.

TABLE No. 4.

VERY VOLATILE LIQUIDS, LIQUEFIED GASES.

	SULPHUROUS ACID.	AMMONIA.	SULPHYDRIC ACID.
T.	F.	F.	F.
°	mm.	mm.	mm.
—78,2		157,95	441,42
—40		528,61	
—35		684,19	
—30		876,58	2808,57
—25	373,79	1112,12	3508.02
—20	479,46	1397,74	4273,01
—15	607,90	1740,91	5090,18
—10	762,49	2149.52	5945,00
— 5	946.90	2632,25	6822,74
0	1165,06	3162,87	7709,27
+ 5	1421.14	3851,47	
10	1719,55	4612,19	
15	2064,90	5479,26	
20	2462,05	6467,00	
25	2915,97	7581,16	
30	3431,80	8832,20	
35	4014,78	10144,00	
40	4670,23	11776,42	
45	5403,52		
50	6220,01		
55	7125,02		
60	8123,80		
65	9221.40		

"The condensation of the gases was effected in the same apparatus which was to serve for the determination of the elastic forces, and which was so arranged that it could be completely purged afterwards of every trace of air or other gas which might be in it. The liquefaction of sulphurous acid was easily effected under the ordinary pressure of the atmosphere when the apparatus was plunged into a freezing mixture. For ammonia and sulphuretted hydrogen, the apparatus was plunged into a mixture of ice and crystallized chloride of calcium, and the gas was then compressed by a hand-pump. Only, care must be taken to replace the ordinary grease for the pump by fixed non-saponifiable oils. A pressure of 2 or 3 atmospheres is sufficient to liquefy as much ammonia as is desired; but for sulphuretted hydrogen the pressure must be carried to 7 or 8 atmospheres.

"As I have had occasion to liquefy these gases on a large scale for researches of which I will soon present the results to the Academy, and especially for the determination of the latent heat of volatilization under different pressures of very volatile liquids, and for the examination of the quantities of heat which their vapors absorb during their expansion, I will here briefly indicate the process which I employed.

"I prepare carbonic acid gas by supplying in a continuous and regular stream, properly-diluted chlorhydric acid to fragments of marble enclosed in a very large glass vessel. The solution deprived of the acid and charged with chloride of calcium flows out as fast as it forms; the carbonic acid gas passes over to a gas receiver of a cubic capacity of 1 cubic metre. A condensing-pump with several barrels, moved by my steam engine, draws the gas from the receiver, and having caused it to pass over drying materials, it forces it into a first recipient of 3 or 4 litres capacity which serves only as a regulator; thence, the gas passes freely into the apparatus in which it is to be condensed, which is buried in a freezing mixture of ice and crystallized chloride of calcium. The gas which does not condense, passes into a second closed recipient of 5 litres capacity. Into this last vessel, the air and other more condensable gases pass, and from it they may from time to time be discharged by opening a stop-cock.

"The same arrangement will serve to liquefy large quantities of protoxide of nitrogen, or sulphuretted hydrogen. But for these gases which are easily rendered impure by contact with the grease and pistons of the pump, I employ a peculiar forcing-pump, in which the gas is in contact only with mercury. This pump is composed of two equal cast iron cylinders, united in the form of a U. The first cylinder is turned, and contains a solid piston which, in its movement, acts only on a quantity of mercury which fills exactly one of the pump cylinders. The suction and compressing (foot and head) valves are attached to the second cylinder. It will be seen that by this arrangement the gas never comes into contact with the piston or the greasy sides.

"Liquid ammonia particularly occupied my attention, owing to its great capacity for heat, its great latent heat of evaporation, and the ease with which it is prepared and collected after it has assumed the gaseous state. I determined to use it principally for obtaining very stationary low temperatures by boiling it under different pressures. I prepare the ammonia as a gas by passing continuously a thread of a concentrated solution of ammonia into a copper tube enclosed in a small boiler containing water which is kept boiling by a gas-light. The ammonia flows in a spiral along the walls, and the liquid, nearly deprived of ammonia, escapes by a tube below, which enters to a depth of several decimetres into the liquid which has previously flowed out.

"The gaseous ammonia, sucked by the pump, traverses several copper recipients filled with soda-lime. The pump itself regulates the production of the gas, and delivers it into the receiver, which is buried in a freezing mixture of ice and hydrated chloride of calcium. By means of this arrangement several litres (quarts) of liquid ammonia may be obtained in a few hours.

"To submit an apparatus to a stationary low temperature, it is hermetically adjusted in the condenser, and the liquid ammonia is condensed in this receiver buried in a freezing mixture. When it is sufficiently filled with the liquid, the freezing mixture is removed and the receiver placed in communication with one of my large air-reservoirs, in which the pressure is kept rigorously stationary, either above or below that of the atmosphere.

"The ammonia thus distils under pressures as light as are desired, which are easily kept perfectly constant, provided the ammoniacal gas is prevented from reaching the air-reservoir. For this purpose, in front of this reservoir is placed a cylindrical vessel containing pieces of ice, which, as they liquefy, almost entirely re-dissolve the ammonia; and after this, another cylinder filled with large pieces of pumice stone soaked with acid.

"I thus hoped to obtain, by means of this apparatus, low temperatures which should be perfectly stationary, but I was not successful for reasons which I have explained before (p. 242). A certain amount of steadiness can only be obtained by passing a continual current of small bubbles of air through the liquid ammonia, which thus continually stirs up the liquid and destroys its viscosity. An air thermometer should be placed in contact with the apparatus experimented on, and plunged entirely in the liquid ammonia; by means of a regulating screw, the current or air-bubbles is controlled so as to keep the thermometer stationary.—*Comptes Rendus de l'Academie des Sciences de Paris,* 11 *Juin,* 1860.

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*On Microscopic Vision and a new Form of Microscope.** By Sir. D. Brewster.

In studying the influence of aperture on the images of bodies as formed in the camera, by lenses or mirrors, it occurred to me that in microscopic vision it might exercise a still more injurious influence. Opticians have recently exerted their skill in producing achromatic object-glasses for the microscope with large angles of aperture. In 1848 the late distinguished optician, Mr. Andrew Ross, asserted "that

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* From the Lond. Athenæum, July, 1860.

135° was the largest angular pencil that could be passed through a microscopic object-glass," and yet in 1855 he had increased it to 170°, while some observers speak of angular apertures of 175°. In considering the influence of aperture, we shall suppose that an achromatic object-glass with an angle of aperture of 170° is optically perfect, representing every object without color and without spherical aberration; when the microscopic object is a cube, we shall see five of its faces, and when it is a sphere or a cylinder, we shall see nine-tenths or more of its circumference. How, then, does it happen that large apertures exhibit objects which are not seen when small apertures with the same focal length are employed? This superiority is particularly shown with test objects marked with grooves or ridges and obliquely illuminated. The marginal part of the lens will enlarge the grooves and ridges, and they will thus be rendered visible, not because they are seen more distinctly, but because they are expanded by the combination of their incoincident images. Hence we have an explanation of the fact—well known to all who use the microscope—that objects are seen more distinctly with object-glasses of small angular aperture. In the one case we have, with the same magnifying power, not only an enlarged and indistinct image of objects, but a false representation of them, from which their true structure cannot be discovered; while in the other we have a smaller and distinct image, and a more correct representation of the object. But these are not the only objections to large angular apertures and short focal lengths. 1. In the first place, it is extremely difficult to illuminate objects when so close to the object-glass. 2. There is a great loss of light, from its oblique incidence on the surface of the first lens. 3. The surface of glass,—with the most perfect polish,—must be covered with minute pores, produced by the attrition of the polishing powder; and light, falling upon the sides of these pores with extreme obliquity, must not only suffer diffraction, but be refracted less perfectly than when incident at a less angle. 4. When the object is almost in contact with the anterior lens, the microscope is wholly unfit for researches in which mechanical or chemical operations are required, and also for the examination of objects inclosed in minerals or other transparent bodies. 5. In object-glasses now in use, the rays of light must pass through a great thickness of glass of doubtless homogeneity. It is a question yet to be solved whether or not, a substance can be truly transparent, in which the elements are not united in definite proportion; in which the substances combined have very different refractive and dispersive powers; and in which the particles are so loosely united that they separate from one another, as in the various kinds of decomposition to which glass is liable. If the best microscopes are affected by these sources of error, every exertion should be made to diminish or remove them. 1. The first step, we conceive, is, to abandon large apertures, and to use object-glasses of moderate focal length, obtaining at the eye-glass any additional magnifying power that may be required. 2. In order to obtain a better illumination, either by light incident vertically or obliquely, a new form of the microscope would be advantageous. In place of directing the microscope to the object itself, placed as it now is, almost touching the object-glass, let it be directed to an image of the object, formed by the thinnest achromatic lens, of such a focal length that the object may be an inch or more from the lens, and its image equal to, or greater, or less than the object. In this way the observer will be able to illuminate the object, whether opaque or transparent, and may subject it to any experiments he may desire to make upon it. It may thus be studied without a covering of glass, and when its parts are developed, by immersion in a fluid. 3. The sources of error arising from the want of perfect polish and perfect homogeneity of the glass of which the lenses are composed, are, to some extent, hypothetical; but there are reasons for believing,—and these reasons corroborated by facts,—that a body whose ingredients are united by fusion, and kept in a state of constraint from which they are striving to get free, cannot possess that homogeneity of structure, or that perfection of polish, which will allow the rays of light to be refracted and transmitted without injurious modification. If glass is to be used for the lenses of microscopes, long and careful annealing should be adopted, and the polishing process should be continued long after it appears perfect to the optician. We believe, however, that the time is not distant when transparent minerals, in which their elements are united in definite proportions, will be substituted for glass. Diamond, topaz, and rock crystal are those which appear best suited for lenses. The white topaz of New Holland is particularly fitted for optical purposes, as its double refractions may be removed by cutting it in plates perpendicular to one of its optical axes. In rock crystal the structure is, generally speaking, less perfect along the axis of double refraction than in any other direction, but this imperfection does not exist in topaz.—Prof. STOKES and Mr. STONEY suggested some modifications of Sir David Brewster's theoretic views; and a member of the Section whose name we did not catch, stated that several attempts had been made to form an image of objects more removed from the first or object-glass of the microscope than at psesent, by using an additional lens, but hitherto without success.—*Proc. Brit. Assoc.*, 1860.

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*On some Optical Illusions connected with the Inverson of Perspective.**

By Sir D. BREWSTER.

The term "Inversion of Perspective" has been applied to a class of optical illusions, well known and easily explained, in which depressions are turned into elevations, and elevations into depressions. One of the most remarkable cases of this kind, which has not yet been explained, presented itself to the late Lady Georgiana Wolf, and has been recorded by her husband, Dr. Wolf. When she was riding on a sand-beach in Egypt, all the foot-prints of horses appeared as elevations, in place of depressions, in the sand. No particulars are mentioned, in reference to the place of the sun, or the nature of the surrounding objects, to enable us to form any conjecture respecting the cause of this phenomenon. Having often tried to see this illusion, I was some time ago so fortunate as not only to observe it myself, but to show it to others. In walking along the west sands of St. Andrew's, the foot-prints, both of men and of horses, appeared as elevations. In a short time they sank into depressions, and subsequently rose into elevations. The sun was at this time not very far from the horizon, on the right hand; and on the left there were large waves of the sea breaking into very bright foam. The only explanation which occurred to me was, that the illusion appeared when the observer supposed that the foot-prints were illuminated with the light of the breakers, and not by the sun. Having, however, more recently observed the phenomenon, when the sun was very high on the right, and the breakers on the left very distant, and consequently very faint, I could not consider the preceding explanation as well founded. Upon attending to the circumstances under which they were now seen, I observed that the human foot-prints were all covered with dry sand that had been blown into them, so that they were much brighter than the surrounding sand, and the dark side of the impression next the sun; and hence it is probable that they appeared to be nearer the eye than the dark sand in which they were formed, and consequently elevations. After repeated examinations of them, I found the foot-prints appeared as elevations as far as the eye could see them; and they were equally visible with one or both eyes. But whenever the eye rested for a little while on the nearest foot-print, it resumed its natural concavity. I have observed other illusions of this kind which are more easily explained, though they differ from any hitherto described. In the Church of Sant' Agostino in Rome, there is above each arch a painted festoon suspended on two short pillars; but, instead of appearing in relief, as the painter intended by shading one side of them, they appeared concave like an intaglio. In other positions in the church they rose into relief. Upon a subsequent visit to the church, I found that the festoon or suspended wreath was concave when it was illuminated—or rather when the observer saw that it was illuminated—by a window beneath it, and in relief when the eye saw that it was illuminated by a window above it, the object being similarly illuminated in both cases. In the common cases of inverted perspective, the eye is deceived by looking at the inversion of the shadow in the cameo or intaglio itself; but in the present case the eye is deceived by perceiving that the body-painting, supposed to be in relief, is illuminated by a light either above or below it. An optical illusion of a different kind presented itself to me in the Church of Santa Giustina at Padua. Upon entering the church we see three cupolas. The one beneath which we stood appeared very shallow; the next appeared much deeper, and the third deeper still. They were all, however, of the same depth, as we ascertained by placing ourselves under each in succession, and observing that it was always the shallowest.

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* From the Lond. Athenæum, July, 1860.

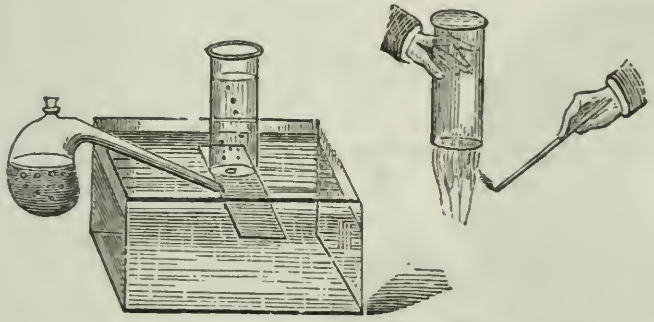
A *Course of Lectures, consisting of Illustrations of the Various Forces of Matter*, i.e. *of such as are called the Physical or Inorganic Forces.**

By M. Faraday, D.C.L., F.R.S.

Lecture IV. (Jan. 5, 1860.)—*Chemical Affinity.—Heat.*

We shall have to pay a little more attention to the forces existing in vater before we can have a clear idea on the subject. Besides the attracion which there is between its particles to make it hold together as a iquid or a solid, there is also another force, different from the former; —one which, by means of the voltaic battery, we yesterday overcame, rawing from the water two different substances, which, when heated y means of the electric spark, attracted each other, and rushed into ombination to reproduce water. Now, the best thing I can do to-day s to continue this subject, and trace the various phenomena of chemial affinity; and for this purpose, as we yesterday considered the chaacter of oxygen, of which I have here two jars (oxygen being those articles derived from the water which enable other bodies to burn), e will now consider the other constituent of water, and without emarrassing you too much with the way in which these things are made, will proceed now to show you our common way of making *hydrogen*. I called it hydrogen yesterday—it is so called because it helps to genrate water.)† I put into this retort some zinc, water, and oil of vitiol, and immediately an action takes place which produces an abunant evolution of gas now coming over into this jar, and bubbling up n appearance exactly like the oxygen we obtained yesterday.

Fig. 1.



The processes, you see, are very different, though the result is the ame in so far as it gives us certain gaseous particles. Here, then, is he hydrogen; I showed you yesterday certain qualities of this gas, ow let me show you some other qualities. It is a combustible subtance, not like the oxygen which is a supporter of combustion although will not burn. There is a jar full of it, and if I carry it along in this anner and put a light to it, I think you will see it take fire, not with bright light,—you will, at all events, hear it if you do not see it. ow, that is a body entirely different from oxygen; it is extremely ght; for although you yesterday saw twice as much of this hydrogen roduced on the one side as the other, by the voltaic battery, it was nly one-eighth the weight of the oxygen. I carry this jar upside down. Why? Because I know that it is a very light body, and that it will continue in this jar upside down quite as effectually as the water will in that jar which is not upside down; and just as I can pour water from one vessel into another in the right position to receive it, so can I pour this gas from one jar into another when they are upside down. See what I am about to do,—there is no hydrogen in this jar at present, but I will gently turn this jar of hydrogen up under this other jar (Fig. 2) and then we will examine the two. We shall see, on applying a light, that the hydrogen has left the jar in which it was at first, and has poured upwards into the other, and there we shall find it.

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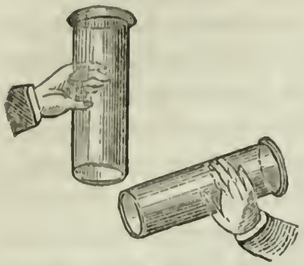
* From the Lond. Chemical News, No. 8.

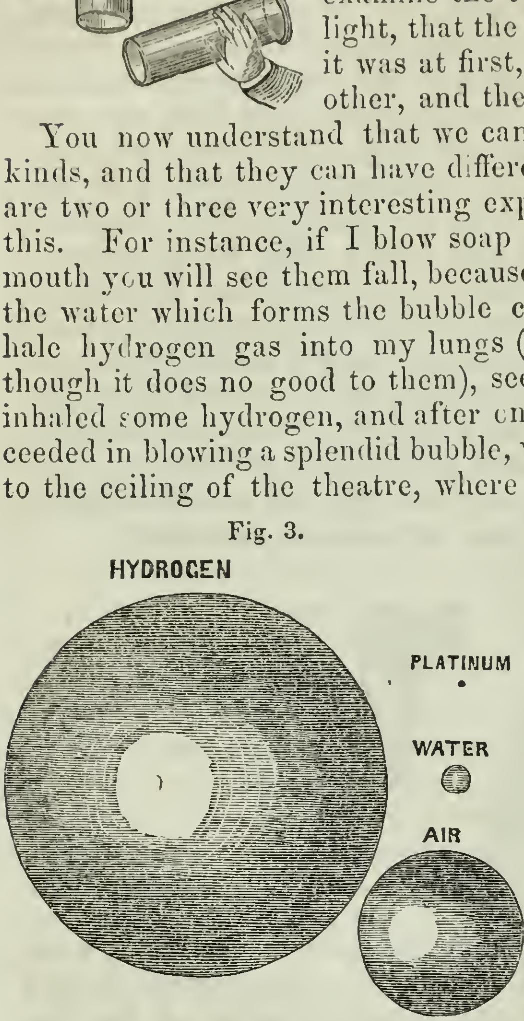
† υδωρ, "water," and γενναω, "I generate."

Fig. 2.



You now understand that we can have particles of very different kinds, and that they can have different bulks and weights; and there are two or three very interesting experiments which serve to illustrate this. For instance, if I blow soap bubbles with the breath from my mouth you will see them fall, because I fill them with common air, and the water which forms the bubble carries it down. But now if I inhale hydrogen gas into my lungs (it does no harm to the lungs, although it does no good to them), see what happens. [The Lecturer inhaled some hydrogen, and after one or two ineffectual attempts, succeeded in blowing a splendid bubble, which rose majestically and slowly to the ceiling of the theatre, where it burst.] That shows you very well how light a substance this is; for notwithstanding all the heavy bad air from my lungs, and the weight of the bubble, you saw how it was carried up. I want you now to consider this phenomenon of weight as indicating how exceedingly different particles are one from the other; and I will take as illustrations these very common things, air, water, the heaviest body–platinum–and this gas, and observe how they differ in this respect; for if I take a piece of platinum of that size (Fig. 3) it is equal to the weight of portions of water, air, and hydrogen of the bulks I have represented in these spheres; and this illustration gives you a very good idea of the extraordinary difference with regard to the gravity of the articles having this enormous difference in bulk. [The following tabular statement having reference to this illustration appeared on the diagram board.]

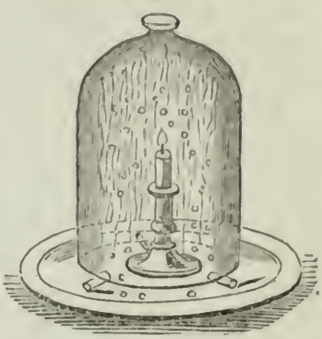
Fig. 3.



Hydrogen, . .	1		
Air, . .	14·4	1	
Water, . .	11943	829	1
Platinum, . .	256774	17831	21·5

Whenever oxygen and hydrogen unite together they produce water, nd you have seen the extraordinary difference between the bulk and ppearance of the water so produced and the particles of which it consists chemically. Now we have never yet been able to reduce either xygen or hydrogen to the liquid state; and yet their first impulse vhen chemically combined is to take up first this liquid condition and hen the solid condition. We never combine these different particles ogether without producing water; and it is curious to think how often ou must have made the experiment of combining oxygen and hydrogen to form water without knowing it. Take a candle, for instance, and clean silver spoon (or a piece of clean tin will lo), and if you hold it over the flame you immeliately cover it with a dew—not a smoke—which resently evaporates. This perhaps will serve o show it better. Mr. Anderson will put a canlle under that jar, and you will see how soon he water is produced (Fig. 4). Look at that limness on the sides of the glass, which will oon produce drops and trickle down into the late. Well, that dimness and these drops are *vater*, formed by the union of the oxygen of he air with the hydrogen existing in the wax of which that candle s formed.

Fig. 4.



And now, having brought you in the first place to the consideration f chemical attraction, I must enlarge your ideas so as to include all ubstances which have this attraction for each other—for it changes he character of bodies, and alters them in this way and that way, in he most extraordinary manner; and produces other phenomena wonlerful to think about. Here is some chlorate of potash, and there is ome sulphuret of antimony. We will mix these two different sets of articles together, and I want to show you in a general sort of way, ome of the phenomena which take place when we make different paricles act together. Now I can make these bodies act upon each other n several ways. In this case I am going to apply heat to the mixture, ut if I were to give it a blow with a hammer the same result would ollow. [A lighted match was brought to the mixture, which immeliately exploded with a sudden flash, evolving a dense white smoke.] There you see the result of the action of chemical affinity, overcoming he attraction of cohesion of the particles. Again, here is a little sugar, uite a different substance from the black sulphuret of antimony, and ou shall see what takes place when we put the two together. [The nixture was touched with sulphuric acid, when it took fire and burnt radually and with a brighter flame than in the former instance.] Oberve this chemical affinity! traveling about the mass, and setting it n fire, and throwing it into such wonderful agitation.

I must now come to a few circumstances which require careful conideration. We have already examined one of the effects of this chemcal affinity—but to make the matter more clear we must point out ome others. And here are two salts dissolved in water. They are both colorless solutions, and in these glasses you cannot see any difference between them. But if I mix them, I shall have chemical attraction take place. I will pour the two together into this glass, and you will at once see, I have no doubt, a certain amount of change. Look, they are already becoming milky, but they are sluggish in their action—not quick as the others were—for we have endless varieties of rapidity in chemical action. Now if I mix them together, and stir them so as to bring them properly together, you will soon see what a different result is produced. As I mix them they get thicker and thicker, and you see the liquid is hardening and stiffening, and before long I shall have it quite hard; and before the end of the lecture, it will be a solid stone—a wet stone no doubt, but more or less solid—in consequence of the chemical affinity. Is not this changing two liquids into a solid body a wonderful manifestation of chemical affinity?

There is another remarkable circumstance in chemical affinity, which is that it is capable of either waiting or acting at once. And this is very singular, because we know of nothing of the kind in the forces either of gravitation or cohesion. For instance, here are some oxygen particles, and here is a lump of carbon particles. I am going to put the carbon particles into the oxygen; they *can* act, but they *do* not—they are just like this unlighted candle. It stands here quietly on the table, waiting until we want to light it. But it is not so in this other case: here is a substance, gaseous like the oxygen, and if I put these particles of metal into it the two combine at once. The copper and the chlorine unite by their power of chemical affinity, and produce a body entirely unlike either of the substances used. And in this other case, it is not that there is any deficiency of affinity between the carbon and oxygen, for the moment I choose to put them in a condition to exert their affinity, you will see the difference. [The piece of charcoal was ignited, and introduced into the jar of oxygen, when the combustion proceeded with vivid scintillations.]

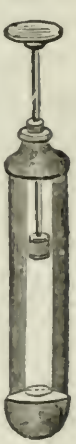
Now this chemical action is set going exactly as it would be if I had lighted the candle, or as it is when the servant put coals on and lights the fire: the substances wait until we do something which is able to start the action. Can any thing be more beautiful than this combustion of charcoal in oxygen? You must understand that each of these little sparks is a portion of the charcoal, or the bark of the charcoal, thrown off white-hot into the oxygen, and burning in it most brilliantly as you see. And now let me tell you another thing, or you will go away with a very imperfect notion of the powers and effects of this affinity. There you see some charcoal burning in oxygen. Well, a piece of lead will burn in oxygen just as well as the charcoal does, or indeed better, for absolutely that piece of lead will act at once upon the oxygen as the copper did in the other vessel with regard to the chlorine. And here also is a piece of iron; if I light it and put it into the oxygen, it will burn away just as the carbon did. And I will take some lead and show you that it will burn in the common atmospheric oxygen at the ordinary temperature. These are the lumps of lead which you remember we had the other day—the two pieces which clung together. Now these pieces, if I take them to-day and press them together, will not stick, and the reason is that they have attracted from the atmosphere a part of the oxygen there present, and have become coated as with a varnish by the oxide of lead which is formed on the surface, by a real process of combustion or combination. There you see the iron burning very well in oxygen, and I will tell you the reason why those scissors and that lead do not take fire whilst they are lying on the table. Here the lead is in a lump, and the coating of oxide remains on its surface, whilst there you see the melted oxide is clearing itself off from the iron, and allowing more and more to go on burning. In this case, however [holding up a small glass tube containing lead pyrophorus], the lead has been very carefully produced in fine powder, and put into a glass tube and hermetically sealed so as to preserve it, and I expect you will see it take fire at once. This has been made about a month ago, and has thus had time enough to sink down to its normal temperature—what you see, therefore, is the result of chemical affinity alone. [The tube was broken at the end, and the lead poured out on to a piece of paper, whereupon it immediately took fire.] Look, look, at the lead burning, why it has set fire to the paper. Now that is nothing more than the common affinity always existing between very clean lead and the atmospheric oxygen; and the reason why this iron does not burn until it is made red-hot, is because it has got a coating of oxide about it which stops the action of the oxygen,—putting a varnish, as it were, upon its surface, as we varnish a picture—absolutely forming a substance which prevents the natural chemical affinity between the bodies from acting.

I must now take you a little further in this kind of illustration, or consideration I would rather call it, of chemical affinity. This attraction between different particles exists also most curiously in cases where they are previously combined with other substances. Here is a little chlorate of potash containing the oxygen which we found yesterday could be procured from it; it contains the oxygen there combined and held down by its chemical affinity with other things; but still it can combine with sugar, as you saw. This affinity can thus act *across* substances, and I want you to see how curiously what we call combustion acts with respect to this force of chemical affinity. Suppose I take a piece of phosphorus and set fire to it, and then place a jar of air over the phosphorus, you see the combustion which we are having there on account of chemical affinity (combustion being in all cases the result of chemical affinity). The phosphorus is escaping in that vapor, which will condense into a snow-like mass at the close of the lecture. But suppose I limit the atmosphere, what then? why, even the phosphorus will go out. Here is a piece of camphor which will burn very well in the atmosphere, and even on water it will float about and burn, by reason of some of it particles gaining access to the air. But if I limit the quantity of air by placing a jar over it, as I am now doing, you will soon find the camphor will go out. Well, why does it go out? not for want of air, for there is plenty of air remaining in the jar. Perhaps you will be shrewd enough to say for want of oxygen.

This therefore leads us to the inquiry as to whether oxygen can do more than a certain amount of work. The oxygen there (Fig. 4) cannot go on burning an unlimited quantity of candle, for that has gone out, as you see; and its amount of chemical attraction or affinity is just as strikingly limited; it can no more be fallen short or exceeded than can the attraction of gravitation. You might as soon attempt to destroy gravitation, or weight, or all things that exist, as to destroy the exact amount of force exerted by this oxygen. And when I pointed out to you that 8 by weight of oxygen to 1 by weight of hydrogen went to form water, I meant this, that neither of them would combine in different proportions with the other, for you cannot get 10 of hydrogen to combine with 6 of oxygen, or 10 of oxygen to combine with 6 of hydrogen—it must be 8 of oxygen and 1 of hydrogen. Now suppose I limit the action in this way: this piece of cotton-wool burns, as you see, very well in the atmosphere; and I have known of cases of cotton-mills being fired as if with gunpowder, through the very finely divided particles of cotton being diffused through the atmosphere in the mill, when it has sometimes happened that a flame has caught these raised particles, and it has run from one end of the mill to the other and blown it up. That, then, is on account of the affinity which the cotton has for the oxygen; but suppose I set fire to this piece of cotton which is rolled up tightly; it does not go on burning, because I have limited the supply of oxygen, and the inside is prevented from having access to the oxygen, just as it was in the case of the lead by the oxide. But here is some cotton which has been imbued with oxygen in a certain manner. I need not trouble you now with the way it is prepared; it is called gun-cotton. See how that burns [setting fire to a piece]; it is very different from the other, because the oxygen that must be present in its proper amount is put there beforehand. And I have here some pieces of paper which are prepared like the gun-cotton, and imbued with bodies containing oxygen. Here is some which has been soaked in nitrate of strontia—you will see the beautiful red color of its flame; and here is another which I think contains baryta, which gives that fine green light; and I have here some more which has been soaked in nitrate of copper,—it does not burn quite so brightly, but still very beautifully. In all these cases the combustion goes on independent of the oxygen of the atmosphere. And here we have some gunpowder put into a case, in order to show that it is capable of burning under water. You know that we put it into a gun, shutting off the atmosphere with shot, and yet the oxygen which it contains supplies the particles with that without which chemical action could not proceed. Now I have a vessel of water here, and am going to make the experiment of putting this fuse under the water, and you will see whether that water can extinguish it; here it is burning out of the water, and there it is burning under the water, and so it will continue until exhausted, and by reason of the requisite amount of oxygen being contained within the substance. It is by this kind of attraction of the different particles one to the other that we are enabled to trace the laws of chemical affinity, and the wonderful variety of the exertions of these laws.

Now I want you to observe that one great exertion of this power which is known as *chemical affinity* is to produce HEAT and light; you know as a matter of fact, no doubt, that when bodies burn they give out heat, but it is a curious thing that this heat does not continue—the heat goes away as soon as the action stops, and you see by that that it depends upon the action *during the time* it is going on. That is not so with gravitation; this force is continuous, and is just as effective in making that lead press on the table as it was when it first fell there. Nothing occurs there which disappears when the action of falling is over; the pressure is upon the table, and will remain there until the lead is removed; whereas, in the action of chemical affinity to give light and heat, they go away immediately the action is over. This lamp *seems* to evolve heat and light continuously, but it is owing to a constant stream of air coming into it on all sides, and this work of producing light and heat by chemical affinity will subside as soon as the stream of air is interrupted. What, then, is this curious condition of heat? Why it is the evolution of another power of matter, of a power new to us, and which we must now consider as if it were the very first time it was brought under our notice. What is heat? We recognise heat by its power of liquefying solid bodies and vaporizing liquid bodies, by its power of setting chemical affinity going and very often overcoming it. Then how do we obtain heat? We obtain it in various ways; most abundantly by means of the chemical affinity we have just before been speaking about, but we can also obtain it in many other ways. Friction will produce heat. The Indians rub pieces of wood together until they get them hot enough to take fire, and such things have been known as two branches of a tree rubbing together so hard as to set the tree on fire. I do not suppose I shall set these two pieces of wood on fire by friction; but I can readily produced heat enough to ignite some phosphorus. [The Lecturer here rubbed two pieces of cedar wood strongly against each other for a minute, and then placed on them a piece of phosphorus, which immediately took fire.] And if you take a smooth metal button stuck on a cork, and rub it on a piece of soft deal wood, you will make it so hot as to scorch wood and paper, and burn a match.

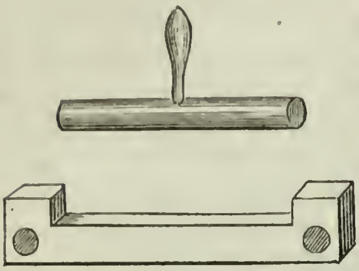
Fig. 5.



I am now going to show you that we can obtain heat not by chemical affinity alone, but by the pressure of air. Suppose I take a pellet of cotton and moisten it with a little ether, and put it into a glass tube (Fig. 5), and then take a piston and press it down suddenly, I expect I shall be able to burn a little of that ether in the vessel. It wants a suddenness of pressure or we shall not do what we require. [The piston was forcibly pressed down, when a flame due to the combustion of the ether was visible in the lower part of the syringe.] All we want is to get a little ether in vapor, and give fresh air each time, and so we may go on again and again getting heat enough by the compression of air to fire the vapor of ether.

This, then, I think, will be enough, accompanied with all you have previously seen, to show you how we procure heat. And now for the effects of this power. We need not consider many of them on the present occasion, because when you have seen its power of changing ice into water and water into steam, you have seen the two principal results of the application of heat. I want you now to see how it expands all bodies—all bodies but one, and that under limited circumstances. Mr. Anderson will hold a lamp under that retort, and you will see the moment he does so that the air will issue abundantly from the neck which is under water, because the heat which he applies to the air causes it to expand. And here is a brass rod (Fig. 6) which goes through that hole and also fits accurately into this gauge; but if I make it warm with this spirit-lamp it will only go in the gauge or through the hole with difficulty; and if I were to put it into boiling water it would not go through at all. Again: as soon as the heat leaves bodies they collapse; see how the air is contracting in the vessel now Mr. Anderson has taken away his lamp; the stem of it is filling with water. And notice now that although I cannot get the tube through this hole or into the gauge, the moment I cool it by dipping it into water, it goes through with perfect facility, so that you see we have a perfect proof of this power of heat to contract and expand bodies.

Fig. 6.



(To be Continued.)

Specification of a Patent granted to Frederick Augustus Abel *for Improvements in Protecting from Fire, Textile Materials in the Raw or in the Manufactured State.**—[Dated 23d December, 1859.]

The improvements forming the subject of this invention consist in affording protection against fire to textile materials in the raw or in the manufactured state, by impregnating such materials with insoluble metallic silicates within the fibre of the material.

The process by which this is effected is as follows:—Prepare a solution of lead, of zinc, or, practically speaking, of any other metallic base capable of forming, by its action upon a soluble silicate, a double silicate, insoluble in water, and, by preference, a basic acetate of lead, prepared, as is well known, by boiling sugar of lead and litharge with water. It has been found that solutions of various strengths will answer the purpose, yet the one preferred is prepared by boiling together twenty-five pounds of sugar of lead, fifteen pounds of litharge, and forty gallons of water, for about half an hour, and allowing the same to stand for about a couple of hours; the decanted clear solution forms a liquor well adapted to the purpose of the patentee.

To use the liquor so prepared, and which, in the present instance, is a solution of basic acetate of lead, the patentee takes such a quantity of it as will be at least sufficient to cover completely the fabric or material intended to be made uninflammable, or else the fabric or material may, in many cases, be simply passed through the liquid, raised to nearly the boiling point; the object being simply to saturate or im-

*From Newton's London Journal, August, 1860.

pregnate it thoroughly with the liquor. This having been done, the fabric so saturated with the liquor is to be removed, and spread out for about twelve hours to the contact of the air. This hanging out of the fabric or material to the air may be dispensed with, but it is preferred to do so, the subsequent operation now to be described yielding then a better result.

The fabric, after having been subjected to the first operation just described, should now be immersed for a period of from one to two hours, or thereabouts, in a hot and moderately strong solution of an alkaline silicate, by preference, in silicate of soda. It should then be withdrawn from the bath of alkaline silicate, allowed to drain, washed thoroughly in soft water, and dried; when it will be found to have acquired the properties claimed for it.

The patentee does not confine himself to the use of any particular silicate, or of any metallic salt, nor to the precise *modus operandi* described; but he claims, "protecting from fire textile materials in the raw or in the manufactured state, by the production of an insoluble silicate within the fibre or texture of the said textile materials.

On the means of Increasing the Angle of Binocular Instruments, in order to obtain a Stereoscopic Effect in proportion to their Magnifying Power.[*] By Mr. A. Claudet.

In a paper on the stereoscope, which Mr. Claudet read before the Society of Arts in the year 1852, alluding to the reduction of the stereoscopic effect produced by opera-glasses on account of their magnifying power, he stated that, in order to reduce that defect, it would be necessary to increase the angle of the two perspectives. This he proposed to do by adapting to the object-glasses two sets of reflecting prisms, which by the greater separation given to the two lines of perspectives, would reflect on the optic axes images taken at a greater angle than the angle of natural vision. Such was the instrument that Mr. Claudet submitted to the British Association, to prove, as he has always endeavored to demonstrate in various memoirs, that the binocular angle of stereoscopic pictures must be in proportion to the ultimate size of the pictures on the retina, larger than the natural angle when the images are magnified, and smaller when they are diminished; which, in fact, is nothing more than to give or restore to these images the natural angle at which the objects are seen when we approach them or recede from them. For magnifying or diminishing the size of objects is the same thing as approaching them or receding from them, and in these cases the angles of perspectives cannot be the same. Mr. Claudet showed that, looking at the various rows of persons composing the audience with the large ends of the opera-glass, all the various rows appeared too close to one another, that there was not between them the distance which separates them when we look with the eyes alone; and he showed also that, with the small end, the distance appeared considerably exaggerated. But, applying the sets of prisms to the opera-glass in order to increase the angle of the two perspectives, then looking at the audience as before, it appeared that the various rows of persons had between them the natural distance expected for the size of the image or for the reduction of the distance of the objects. By applying the two sets of prisms before the eyes without the opera-glass, it was observed, as was to be expected, that the stereoscopic effect was considerably exaggerated, because the binocular angle was increased without magnifying the objects. But looking with the two sets of prisms alone at distant objects, the exaggeration of perspective did not produce an unpleasant effect. It appeared as if we were looking at a small model of the objects brought near the observer. By the same reason, stereoscopic pictures of distant objects (avoiding to include in them near objects) can advantageously be taken at a larger angle than the natural angle, in order to give them the relief of which they are deprived as much when we look at them with the eyes, as when we look only with one eye; instead of being a defect, it seems that it is an improvement. In fact, the stereoscope gives us two eyes to see pictures of distant objects.—*Proc. Brit. Assoc.*, 1860.

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[*] From the London Athenæum, July, 1860.

*On the Principles of the Solar Camera.** By A. Claudet.

The solar camera invented by Woodward, is one of the most important improvements introduced in the art of photography since its discovery. By its means, small negatives may produce pictures magnified to any extent; a portrait taken on a collodion plate not larger than a visiting-card, can be increased, in the greatest perfection, to the size of nature; views as small as those for the stereoscope can be also considerably enlarged. This is an immense advantage, which is easily understood when we consider how much quicker and in better proportion of perspective small pictures are taken by the camera obscura, while the manipulation is so greatly simplified. There is nothing new in the enlargement of photographic pictures. This has been done long ago simply by attending to the law of conjugate foci; and every photographer has always been enabled, with his common camera, to increase or reduce the size of any image. For the enlargement, it was only necessary to place the original very near the camera, and to increase in proportion the focal distance. But the more the focal distance was increased, the more the intensity of light was reduced; and a still greater loss of light arose from the necessity of diminishing the aperture of the lens, in order to avoid the spherical aberration. Such conditions rendered the operation so long that it became almost an impossibility to produce any satisfactory results when the picture was to be considerably enlarged. For these reasons, it naturally occurred that if the negative, having its shadows perfectly transparent and its lights quite black, was turned against the strong light of the sun, its positive image at the focus of the camera would be so intense that the time of exposure would be considerably reduced. So that, in order to employ the light of the sun, and follow easily its position without having to move constantly the whole camera, it was thought advisable to employ a movable reflecting mirror, sending the parallel rays of the sun on a vertical plano-convex lens condensing those rays on the negative, placed before the object glass and behind the condenser, somewhere in its luminous cone. Many contrivances for this object were resorted to, but without considering any thing else than throwing the strongest light possible on the negative to be copied. The constructors of these solar cameras never thought it very important to consider whether the focus of the condensing lens was better to fall before or behind the front of the object glass, provided the negative was placed in the luminous cone of the condenser. This want of attention has been the cause which has made the solar camera a very imperfect instrument for copying negatives. The beautiful principle of Woodward's apparatus consists in his having decided the question of the position of the focus of the condenser, and in having placed it exactly on the front lens of the camera obscura. As this principle had not yet been explained when the invention was exhibited before the Photographic Societies of London and Paris, and not even by the inventor himself in the specification of his patent, Mr. Claudet has undertaken, in the interest of the photographic art, to bring the subject before the British Association, and to demonstrate that the solar camera of Woodward has solved the most difficult problem of the optics of photography, and is capable of producing wonderful results. This problem consists in forming the image of the negative to be copied only by the centre of the object-glass reduced to the smallest aperture possible, without losing the least proportion of the light illuminating the negative. The solar camera does not require any diaphragm to reduce the aperture of the lens, because every one of the points of the negative are visible only when they are defined on the image of the sun, and they are so (in that position exclusively), for the centre of the lens is the only point which sees the sun, while the various points of the negative which form the marginal zone of the lens, are defined against the comparatively obscure parts of the sky surrounding the sun, are, as it were, invisible to that zone; so that the image is produced only by the central rays, and not in the least degree by any other points of the lens, which are subject to spherical aberration. It is, in fact, a lens reduced to an aperture as small as is the image of the sun upon its surface, without the necessity of any diaphragm, and admitting the whole light of the sun after it has been condensed upon the various separate points of the negative. It is evident that, from the centre of the lens the whole negative has for background the sun itself, and from the other points of the lens it has for background only the sky surrounding the sun, which fortunately has no effect in the formation of the image. Such is the essential principle of Woodward's solar camera, which did not exist in that instrument when the focus of the condenser was not on the object-glass. This principle is truly marvellous, but it must be observed that the solar camera, precisely on account of the excellence of this principle, requires the greatest precision in its construction. For its delicate performances, it must be as perfect as an astronomical instrument, which, in fact, it is. The reflecting mirror should be plane, and with parallel surfaces, in order to reflect on the condenser an image of the sun without deformation; and in order to keep the image always on the very centre of the object-glass, the only condition for the exclusion of the oblique rays, the mirror should be capable by its connexion with a heliostat of following the movements of the sun. The condenser itself should be achromatic, in order to refract the image of the sun without dispersion, and to define more correctly the lines of the negative; and a no less important condition for losing nothing of the photogenic rays would be, to have it formed with a glass perfectly homogeneous and colorless. With such improvements, the solar camera will become capable of producing results of the greatest beauty; and, without any question, its introduction into the photographer's studio will mark a period of considerable improvement in the art.—*Proc. Brit. Assoc.*, 1860.

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*From the London Athenæum, July, 1860.

*On the Perception of Colors.** By Dr. GLADSTONE.

The author described himself as in an intermediate position between those who have a normal vision of colors, and those who are termed "color-blind." These latter are usually unacquainted with the sensations of either red or green, and it becomes a desideratum to have good observations on those who are capable of acting somewhat as interpreters between them and those who perceive every color. By means of Chevreul's chromatic circles and scales, Maxwell's color-top, colored beads, &c., the author was able to determine the following points in respect to his own vision. He sees red, in all probability, like other people, but it requires a larger quantity of the color to give the sensation than is usually the case; hence a purple appears to him more blue, and an orange more yellow, than to the generality of observers. He is perfectly sensible of green, or rather of two distinct greens,—the one yellowish, the other blueish,—but between them there lies a particular shade of green, to which his eyes are insensible as a color. This modifies his perception of many greens that approximate to what is to him invisible. The shade occurs in nature on the back of the leaf of the variegated holly, and it may be produced in Maxwell's top by certain combinations of the colored disc; the simplest being:—

94·5 Brunswick Green (Blue Shade) + 5·5 Ultramarine = 94 Black + 6 White.

While able perfectly to distinguish between red and green, the contrast does not readily catch his eye, especially at a distance; in fact, he is somewhat short-sighted in respect to these colors. He has reason to believe that, in his case, there has been a gradual improvement in his actual perception of colors, independently of his greater knowledge of them, though this is in opposition to the general experience of those whose vision is in any way abnormal, and no other instance was known to the late Prof. George Wilson, whose book is the standard one on the subject of color-blindness.

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* From the London Athenæum, July, 1860.

*On the Use of Granite.** By Gardner Wilkinson.

As the question of using granite for building and monumental purposes has been much discussed, I beg to offer a few remarks connected with it, and to notice a fact which shows at how early a period the ancient Egyptians had watched the effect of atmospheric and other influences on stone, and how wisely they profited by the lessons taught them by experience. They had learnt that earth, abounding with nitre, from its attracting moisture, had the effect of decomposing granite, but that in the dry climate of Upper Egypt the stone remained for ages uninjured when raised above all contact with the ground. When, therefore, there was a possibility of its being exposed to damp, they based an obelisk, or other granite monument, on limestone substructions; and these last are found to the present day perfectly preserved, while the granite above them gives signs of decay in proportion to its contact with the earth subsequently accumulated about it. I am speaking of Upper Egypt, visited only four or five times in a year by a shower of rain; for in the Delta granite remains have been affected in a far greater degree than in the Thebaïd. Nitre abounds there, and it is remarkable that the obelisks at Alexandria have suffered least on the sides next the sea.

The Egyptians seldom used granite as a building stone, except for a small sanctuary in some sandstone temple; and in the later times of the Ptolemies one or two temples were built entirely of granite. But in the pure Egyptian period, that stone was chiefly confined to the external and internal casing of walls, to obelisks, doorways, monolithic shrines, sarcophagi, statues, small columns, and monuments of limited size, and was sometimes employed for roofing a chamber in a tomb.

The durability of granite varies according to its qualities. The felspar is the first of its component parts which decompose, and its greater or less aptitude for decay depends on the nature of the base of which the felspar consists. Egypt produces a great variety of granite, and the primitive ranges in the desert, east of the Nile, about 35 miles from the Red Sea, supplied the Romans, with numerous hitherto unknown kinds, as well as with porphyry, which they quarried so extensively in that district; but the granite of the ancient Egyptians came from the quarries of Syene, in the valley of the Nile, and from these they obtained what was used for their monuments. It is from this locality that the name of "Syenite" has been applied to a certain kind of granite; it is, however, far from being all of the same nature, and a small portion of the stone found there is really what we now call "Syenite."

Already, at the early period of the third and fourth dynasties, between twelve and thirteen centuries before the Christian era, the Egyptians extensively employed granite for various purposes. They had learnt to cut it with such skill that the joints of the blocks were fitted with the utmost precision. Deep grooves were formed in the hard stone with evident facility; and it must have been known to them for a long period before the erection of the oldest monuments that remain—the Pyramids of Memphis, where granite was introduced in a manner which could only result from long experience. Again, in the time of the first Osirtasen, about 2050 B. C., granite obelisks were erected at Heliopolis, and in the Fyoóm, and other granite monuments were raised in the same reign at Thebes; from which we find that even then the Egyptians had learnt how the damp earth acted on granite when buried beneath it; and this interesting question subsequently suggests itself—how long before that time must the stone have been used to enable them to obtain from experience that important hint which led them to place granite on limestone substructions?

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*From the London Builder, No. 907.

I have already had occasion to offer some remarks on the mode of treating granite surfaces, which has been so ably detailed by Mr. Bell, at the meeting of the Society of Arts (March 14); and I have stated that the Egyptians adopted the broad character of ornamentation in sculpturing granite very judiciously advocated by him. I will, therefore, only add, that other good examples of such treatment may be found in early crosses of Cornwall, Devonshire, and other localities in this country; where what has been (rather hastily) called the Runic knot,—a design of entwined basket-work, common also in Italy, and other countries,—the large scroll pattern also frequently met with on the same monuments, and numerous massive ornaments in relieved intaglio, cut in the thickness of the stone are instances of a style of decorative sculpture admirably suited to granite.

*Great Achievement of Mechanical Ingenuity.**

There is now to be seen at Bennett's, the well-known watch manufacturer of Cheapside, a gold hunting-watch of so remarkable a character as to well deserve description in our columns. In addition to being a time-keeper of the utmost precision, with chronometer adjustments, compensation balance, and cylindrical spring, it exhibits on the dial-plate the following different indications: first, the equation of time; secondly, the moon's age; thirdly, the month of the year; fourthly, the day of the month, in addition to the hours, minutes, and seconds, as in an ordinary watch. The mechanism is so contrived that any one or the whole of the hands may be set forwards or backwards at pleasure without deranging the rest. Mr. Bennett, the manufacturer of this remarkable production, naturally regards it as one of the highest triumphs of modern horological science; for these extraordinary time-keepers have hitherto been considered rather as mechanical marvels than as of practical use. In this case every movement is laid down in the strictest proportion, and based upon calculations of an absolutely scientific character. Although it has taken more than a twelve-month in its production, and is inclosed in a handsome gold case, it is within the compass of a pocket time-keeper. We strongly recommend those of our readers interested in mechanical science, to avail themselves of the opportunity of gratifying their curiosity as to what is possible to be effected by the enterprise of one of our leading watch manufacturers.

* From the Lond. Mechanics' Mag., June, 1860.

*On a New Form of Chloride of Sodium.** By Richard V. Tuson, Lecturer on Chemistry at Charing Cross Hospital.

That chloride of potassium, which ordinarily crystallizes in cubes is nevertheless often found as an efflorescence on various vegetable extracts assuming the acicular form is well known.

Hitherto, I believe, the corresponding compound, chloride of sodium, has never been observed in needle-shaped crystals but nearly always in cubes.

Occasionally, however, it deposits from urine in octahedra, and when a solution of the salt in water is evaporated at a temperature not exceeding 14° F. it crystallizes in hexagonal tables (Ehrenberg) which contain, according to Fuchs, six equivalents, but, according to Mitscherlich, four equivalents of water of crystallization. At temperatures above 14° F. these hexagonal crystals lose their water of crystallization and are resolved into a congeries of minute cubes. Chloride of sodium, it is also stated, may be obtained in large oblique rhombic prisms having the formula $NaCl + 4Ag$. They effloresce in air below 32° F. (Mitscherlich), deliquesce (? effloresce) in air above 32° F. (Fuchs), and leave a powder of small tubes.

Lately on opening a tightly-fitting tin box, in which a quantity of salmon-roe paste had been allowed to remain for nearly three years, it was found that the organic matter was covered by an efflorescence of acicular crystals. One of my pupils collected some of these crystals, analyzed them, and pronounced them to consist entirely of chloride of sodium. As I had never heard of chloride of sodium crystallizing in needles, their examination was repeated, but still the same results were obtained. Some of the crystals were next dissolved in water, and the solution produced submitted to spontaneous evaporation, when the whole of the salt deposited in the ordinary or cubical form. This result, therefore, fully confirms the conclusions deduced from analysis.

The crystals, some of which are nearly half an inch long, appear to be rectangular prisms terminated by four-sided pyramids. They are beautifully clear, colorless, transparent, elastic, longitudinally and transversely striated, and many are bent or contorted in a manner similar to the native hydrated sulphate of lime called selenite by mineralogists.

The acicular crystals are anhydrous and undergo no change in form or diminution in transparency when exposed to air at ordinary temperatures, or even at a low red heat. The needles of chloride of sodium possess one property which is a very familiar characteristic of the cubical salt, namely, that when heated they decrepitate. It is singular to remark, that, at all events as far as we know at present, the acicular varieties of the chlorides of potassium and of sodium are only developed in the presence of organic matter, just as the production of octahedral chloride of sodium appears to be due to the solution from which it crystallizes containing urea.

Since writing the foregoing, I have observed an efflorescence of acicular chloride of sodium on an animal deposit which was sent me for analysis, and which had been originally mixed with a solution of common salt to prevent it undergoing putrefaction.

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* From the Lond. Chemical News, No. 34.

*A New Kind of Bath.**

M. Mathieu (de la Drôme) one of the most eminent orators of the "Mountain" in the National Assemblies of 1848 and 1849, has lately been turning his attention to the subject of medicinal baths. A bath by immersion requires from two to three hectolitres of water, which, in the case of mere river or spring water, is of no consequence as regards expense. But the case is far different when the water is to be impregnated with medicinal substances, some of which are very costly; or when mineral waters are prescribed, which cannot be had in large quantities without considerable outlay, except at the spring from which they are derived. M. Mathieu (de la Drôme) has therefore endeavored to ascertain, both by calculation and experiment, what is the real quantity of water which produces a useful effect on a human body in a common bath, and has found that it cannot be more than three or four litres in the course of an hour. To distribute this quantity both equally and economically on the body was, therefore, the question to be solved; and he has accordingly invented an apparatus, which he calls *bain hydrofère*. The patient is seated in a kind of box like that used for fumigation, while a powerful ventilator outside transforms the water which is to be used into a minute aqueous dust or dew, just as we see a high wind do with the water issuing from the jets of a monumental fountain. This dew is driven into the box through an aperture on a level with the knees; owing to the extreme minuteness of its particles, the latter ascend, and then gradually subside on the body. In a short time these particles coalesce and trickle down the body, until at last the water descends in an unceasing stream. This system has now been tried with great success at the Hôpital St. Louis, and is now generally attracting the attention of medical men.

*From the London Engineer, No. 232.

The Specific Gravity of Mixtures of Alcohol and Water.†

After three series of determinations which have occupied him more than a year, H. von Baumhauer has arrived at the conviction that the specific gravities of mixtures of alcohol and water, as determined by Gilpin, Löwitz, and Gay-Lussac, are very incorrect. In the first series of experiments the mixtures were made by volume, but as these gave results so different from those generally received, the author repeated his experiments with mixtures made by weight as well as by measure. These, however, only confirmed the results previously obtained. The author started with absolute alcohol having a sp. gr. of 0·7946 at 59° F. In the second series, alcohol from another source was used, which had the sp. gr. 0·7947 at the same temperature. The water used in the experiments was distilled and carefully deprived of air. After corrections for slight mistakes, the results obtained were as follows:—

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† From the Lond. Chemical News, No. 18.

Alcohol in 100 of the mixture.	1st Series.	2d Series.
100	0·7939	0·7940
95	0·8119	0·8121
90	0·8283	0·8283
85	0·8138	0·8432
80	0·8576	0·8572
75	0·8708	0·8708
70	0·8837	0·8938
65	0·8959	0·8963
60	0·9079	0·9081
55	0·9193	0·9196
50	0·9301	0·9302
45	0·9394	0·9100
40	0·9485	0·9491
35	0·9567	0·9569
30	0·9635	0·9636
25	0·9692	0·9696
20	0·9746	0·9747
15	0·9799	0·9800
10	0·9855	0·9855
5	0·9919	0·9918
0	0·9991	0·9991

The Green Coloring Matter of Leaves.[*]

M. Frémy has also studied the constitution and composition of chlorophyll, which he supposes to be made up of two coloring matters, a blue and yellow, the first of which he names *phyllocyanine*, and the second *phylloxanthine*. M. Frémy discovered that by the action of some bases the green matter of leaves is changed to a beautiful yellow substance, which is easily dissolved by alcohol. In this solution, hydrochloric and some other acids will immediately restore the primitive green color. To separate the blue and yellow matters, M. Frémy proceeded as follows:—He first placed in a stoppered bottle two parts of ether and one part of hydrochloric acid, diluted with a little water, and then shook the bottle strongly for some time. He then submitted to the action of this liquid the body produced by the decolorization of the chlorophyll, shaking them together for some seconds. The effect was very remarkable. The ether dissolved the yellow matter of the leaves and became of a beautiful yellow color, while the hydrochloric acid reacted upon the green matter which had been decolorized, and produced a magnificent blue. The two colors are thus isolated, and, being retained by two different liquids, cannot be mixed to reproduce the green; but if the liquids are separated and the coloring matters withdrawn from them, solution in alcohol, which dissolves both, gives immediately a green tint comparable to that of the original chlorophyll. M. Frémy entertains some reasonable doubts whether his phyllocyanine and phylloxanthine really exist in vegetables, and proposes to continue and extend his investigations on the subject. The whole subject is very interesting, and deserves a longer notice than we can give in this correspondence.

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[*] From the London Chemical News, No. 19.

Vegetable Coloring Matters.[*]

M. Filhol has been engaged in the examination of vegetable coloring matters, and has discovered some facts which he now publishes as briefly as possible, intending to give all the details in a longer memoir. There exists in nearly all flowers, says M. Filhol, a substance which is scarcely colored when in solution in acid liquids, but which becomes of a beautiful yellow color when acted on by alkalies. This substance has the following properties. It is solid and of a slightly greenish-yellow color. It is uncrystallizable, soluble in water, alcohol, and ether, and not volatile. When moistened with strong hydrochloric acid, it takes a bright yellow tint which immediately disappears when the mixture is diluted with water, leaving an almost colorless solution to which alkalies communicate a yellow color. The matter is found in the green parts of plants as well as the flowers, and is, no doubt, the yellow dye found in the leaves of various plants. M. Filhol adopts the name given to it by Hope, and calls it *Xanthogene.* Mosses, he says, do not contain it, or, at most, only a trace. It is also absent from some flowers, among others the *Pelargonium Zonale*, and *inquinans Papaver rheas*, Camellias and Salvias. These flowers under the influence of alkalies become blue or violet without the least mixture of green. The coloring matter of these flowers is much less alterable under the influence of air and alkalies than that of most other flowers.

Chemists who have examined yellow flowers, have proved that they owe their color to several immediate principles; among others, *xanthine* and *xantheine.* The author has discovered *xanthine* in fruits as well as flowers.

[*] From the Lond. Chemical News, No. 19.

On the Density of Saturated Steam, and on the Law of Expansion for Superheated Steam.[†] By WILLIAM FAIRBAIRN, F. R. S.

At the last meeting of the British Association, I detailed a new method of ascertaining the specific gravity of vapors, which, in conjunction with my friend Mr. Tate, I was employing with a view to ascertain the density of steam at all temperatures. It may be of interest to the Association to know, that I believe the method to have proved itself reliable, and that we have now experimental determinations of the density of steam; and these fully verify the anticipations of Mr. Thomson and Mr. Rankine, that the vapor of water does not accurately obey the gaseous laws. We have found the density of saturated steam always greater than that given by the gaseous steam, even for temperatures as low as 136° Fah., and for pressures less than that of the atmosphere.

[†] From the Lond. Civ. Eng. and Arch. Journal, Aug., 1860.

The experiments as they stand at present extend over a range of temperature from 136° to 292° Fah., or from 2·6 to 60 lbs. pressure per square inch. But as we hope to extend them to higher pressures, I have preferred to leave at present the consideration of their bearing on other formulæ, and the ultimate generalizations to which they may lead in regard to the use of steam. The following simple formula, however, very nearly expresses the results of the experiments as to the density and pressure of saturated steam, the relation between pressure and temperature having been already determined with scrupulous accuracy by the elaborate investigations of Regnault.

Let V be the specific volume of the steam, or volume as compared with that of an equal weight of water; P = the pressure in inches of mercury. Then I find

$$\mathrm{V} = 25{\cdot}62 + \frac{49513}{\mathrm{P} + {\cdot}72}.$$

Table of Results, showing the Relation of Density and Pressure of Saturated Steam.

No.	Pressure.		Temperature, Fahrenheit.	Specific volume.		Proportional error of formula.
	In lbs. per square inch.	In inches of mercury.		From experiment.	By formula.	
1	2·6	5·35	136·77	8266	8183	+ 1–100
2	4·3	8·62	155·33	5326	5326	0
3	4·7	9·45	159·36	4914	4900	— 1–350
4	6·2	12·47	170·92	3717	3766	+ 1–74
5	6·3	12·61	171·48	3710	3740	+ 1–123
6	6·8	13·62	174·92	3433	3478	+ 1–76
7	8·0	16·01	182·30	3046	2985	— 1–50
8	9·1	18·36	188·30	2620	2620	0
9	11·3	22·88	198·78	2146	2124	— 1–97
1	26·5	53·61	242·90	941	937	— 1–235
2	27·4	55·52	244·82	906	906	0
3	27·6	55·89	245·22	891	900	+ 1–100
4	33·1	66·84	255·50	758	758	0
5	37·8	76·20	263·14	648	669	+ 1–32
6	40·3	81·53	267·21	634	628	— 1–100
7	41·7	84·20	269·20	604	608	+ 1–150
8	45·7	92·23	274·76	583	562	— 1–29
9	49·4	99·60	279·42	514	519	+ 1–100
11	51·7	104·54	282·58	496	496	0
12	55·9	112·78	287·25	457	461	+ 1–114
13	60·6	122·25	292·53	432	428	— 1–108
14	56·7	114·25	288·25	448	456	+ 1–56

The above table exhibits accurately the results at which we have arrived in regard to saturated steam; we have also obtained some results on the rate of expansion of superheated steam. These results are at present less complete than those upon saturated steam, as they do not range more than 20 degrees of temperature in each case above the maximum temperature of saturation. They appear, however, to show conclusively, that near the saturation point steam expands very irrregularly, thus agreeing with what we know of other bodies in their physical relations at or near the point at which they change their state of aggregation. Close to the saturation point we find a very high rate of expansion, but this rapidly declines as the steam superheats, and at no great distance above it the rate of expansion nearly approximates to that of a perfect gas.

Thus, for instance, in Experiment 6, where the point of maximum saturation was 174·92, between this and 180° the steam expanded at the rate of $\frac{1}{196}$, whereas air would have expanded $\frac{1}{634}$; but on continuing the superheating, the co-efficient was reduced between 180° and 200° from $\frac{1}{195}$ to $\frac{1}{637}$, and for air the co-efficient would have been $\frac{1}{635}$, or almost exactly the same: and this rule holds good in every experiment; a high rate of expansion close to the saturation point diminishing rapidly to an approximation to that of air.

AMERICAN PATENTS.

AMERICAN PATENTS ISSUED FROM JULY 1, TO JULY 31, 1860.

Air or Gases,—Exhausting	R. W. Sievier,	U. Holloway,	Engl'd,	17
Anchors,—Appa's for Working	Angus Campbell,	Jersey City,	N. J.	3
Aniline Colors,—Preparation of	Joseph Renard,	Lyons,	France,	31
Awning Fixtures,	Edward Peach,	Utica,	N. Y.	31
Axe Helves,—Metal Cap for	A. W. Porter	St. Johnsville,	Vt.	17
Axles,—Car	Wm. Phelps,	Sycamore,	Ill.	3
Axletrees,—Setting	Arvin & Perkins,	Valparaiso,	Ind.	17
Bandages,—Catamenial	Dahis & Doermer,	Brooklyn,	N. Y.	31
Battery,—Chain Shot	C. B. Thayer,	Boston,	Mass.	24
Bed and Chair,—Combined	G. A. Keene,	Lynn,	"	3
Bed Cord,	Stephen Albro,	Buffalo,	N. Y.	3
Bedstead,—Secretary	George Gage,	Kendall's Mills,	Me.	24
Bee-hives,	Nathan Brasher,	Green Fork,	Ind.	31
———	Matthias M'Gonnigle,	Alleghany,	Penna.	31
Belt Lacing	H. A. Alden,	Matteawan,	N. Y.	31
Bench Hook,	Russel Frisbie,	Middletown,	Conn.	10
Bending Wood,—Machine for	Seidle & Eberly,	Mechanicsburg,	Penna.	10
Blind Slat Machine,	Johnson & Doyle,	Wetumpka,	Ala.	31
Boat-lowering Apparatus,	Flowers & Patton,	Bangor,	Me.	24
Bone Black,—Washing	Chas, Kinzler,	City of	N. Y.	10
Boots and Shoes,	N. C. Lewis, Jr.,	Boston,	Mass.	24
———,—Heel for	D. E. Somes.	Biddeford,	Me.	24
Bowls,—Making Wooden	Simonds & Goodspeed,	Ludlow,	Vt.	31
Brake,—Horse-power	Harvey & Becker,	Amsterdam,	N. Y.	24
Brake,—Self-acting Sleigh	Jacob Dutcher,	Gibson,	Penna.	24
Brake,—Wagon,	J. H. H. Bennett,	Hunt's Hollow,	N. Y.	24
———	H. W. Norville,	Livingston,	Ala.	24
Brakes,—Railroad	C. F. Langford,	Fall River,	Mass.	3
Bread,—Manufacture of	Benjamin Garvey,	City of	N. Y.	17
Brick Machines,	I. M. Gattman,	Cincinnati,	Ohio,	3
———	James Hotchkiss,	Yellow Springs,	"	17
Bridle Bits,	W. F. and W. R. Johnson,	Wetumpka,	Ala.	24
Broom,	Langdon & Weitman,	Hazleton,	Iowa,	17
——— or Brush,	J. H. Power,	Middletown,	"	10
Buckles,	S. S. Hartshorn,	New Haven,	Conn.	24
———	John Tiebout,	Brooklyn,	N. Y.	24

Burglar Alarm,	A. H. Enholm,	St. Louis,	Mo.	3
Butter Worker,	C. A. Boynton,	Hyde Park,	Vt.	17
Cables —Surge-reliever for	James Bingham,	Philadelphia,	Penna.	24
Calendar,—Pocket	H. C. Foote,	McGaheysville,	Va.	17
Candles,—Apparatus for Mould'g	G. A. Stanley,	Cleveland,	Ohio,	31
Candlestick,	H E. Rogers,	S. Manchester,	Conn.	24
Car Bodies with Trucks,	C. S. Moore,	Alexandria,	Va.	3
Carpet-sweeper,	Daniel Hess,	West Union,	Iowa,	10
Carriage Body,	Ernst Kirsch,	New Haven,	Conn.	31
——— Tops,—Movable	J. S. Belcher,	Albany,	N. Y.	10
Cartridge Case,	J P. Lindsay,	City of	"	24
Cartridges,	B. B. Hotchkiss,	Sharon,	Conn.	10
———,—Packing	Christian Sharps,	Philadelphia,	Penna.	10
Casting,—Moulds for	S. A. Corser,	Northampton,	Mass.	10
Center-board Vessels,—Constr'n	Ketchum & Hunt,	Port Jefferson,	N. Y.	10
——— for Vessels,	Daniel G. Gerard,	Patchogue,	"	3
Chimney Cap,	T. J. Fitzpatrick,	New Orleans,	La.	24
Chimneys,	B. W. Taber,	Quaker Street,	N. Y.	24
Churn,	Levi Bissell,	N. Bergen,	"	10
———	N. B. Cooper,	Gratis,	Ohio,	3
———	John Raff,	Eden,	N. Y.	17
———	John Park,	Joliet,	Ill.	31
———	Sherman & Fenwick,	Union Town,	Md.	31
Clap-boarding Gage,	H. D. Vandercook,	Marshall.	Mich.	17
Clothes-frame,	C. A. Boynton,	Hyde Park,	Vt.	3
———	C. J. Ferguson,	City of	N. Y.	17
———	Asa Greenwood,	Toulon,	Ill.	17
———	Wm. Hathaway,	Providence,	R. I.	3
Clocks,—Pendulum	G. M. Phelps,	Troy,	N. Y.	10
Cocks,	Barton Pickering,	Dayton,	Ohio,	24
Coffee Pots,	John Denley,	Warsaw,	Ill.	24
———	George Neilson,	Boston,	Mass.	24
Condensing Apparatus,	G. S. G. Spence,	"	"	31
Condensers,	A. C. Brown,	Philadelphia,	Penna.	10
Copper Vessels,—Planishing	H. Kay & T. Avery, Jr.,	Brooklyn,	N. Y.	17
Corn Planters,	Samuel Avery,	Pisgah,	Mo.	10
———	F. A. Goddard,	Lexington,	Ill.	31
———	John Price,	Harrison,	Ohio,	10
———	Christopher Smith,	Nauvoo,	Ill.	31
—— Shellers,	T. J. Newland,	Wolcott,	Vt.	17
—— Stalks,—Shocking	S. B. Lawrence,	Hookstown,	Penna.	24
Cotton Bale Fastenings,	T. McIntire,	Franklin Furn.	Ohio,	17
——— ——— Ties,	Z. W. and E. D. Lee,	Blakely,	Ga.	3
——— Pickers,	John Griffin,	Louisville,	Ky.	3
———	Lewis Jennings,	Brooklyn,	N. Y.	31
——— Seed Hullers,	P. Martin,	New Orleans,	La.	31
——— Planters,	Zina Doolittle,	Perry,	Ga.	10
Couplings,—Car	J. P. Mendenhall,	Farmington,	Ill.	31
———	I. W. Van Houten,	Philadelphia,	Penna.	3
——— for City R. R. Cars,	Collyer & Patterson,	"	"	17
——— R. R. Cars,	Otis Hood, Jr.,	Turner,	Me.	17
———	Thorp & Shurtleff,	"	"	17
——— of Thills for Axles,	John McDermott,	Washington,	D. C.	24
———	Robert Morrison,	Rahway,	N. J.	24
——— ———	James Sadler,	Egremont,	Mass.	24
Cracker Machine,	Cyrus Marsh, 2d,	Natchez,	Miss.	24
Cranes,	J. T. Smith,	Portsmouth,	Va.	10
Cultivators,	Agnew & Morrison,	Chadd's Ford,	Penna.	10
———	Ephraim Briggs,	Medina,	Ohio,	17
———	Council Clark,	Andersonville,	Ga.	3
———	Ezra Emmert,	Franklin Grove,	Ill.	31
———	Z. W. and E. D. Lee,	Blakely,	Ga.	31

Cultivators,	J. B. Livezey,	Clarksboro',	N. H.	10
———	Lostutter & Wolcott,	Rising Sun,	Ind.	31
———	Harrison Ogborn,	Greenfork,	"	10
———,—Cotton	T. H. Dodge,	Washington,	D. C.	17
———	Richard J. Gatling,	Indianapolis,	Ind.	3
———	J. A. Hartsfield,	Kinston,	N. C.	17
———	Hinman & French,	Watertown,	Mass.	10
———	Rigell & Ivey,	Dawson,	Ga.	17
———	Jesse Speer,	Hazlehurst,	Mass.	31
———	G. W. N. Yost,	Yellow Springs,	Ohio,	17
Curtain Fixture,	Wm. Cleveland,	City of	N. Y.	24
Cylinders,—Turning	Gideon Sibley,	Troy,	"	3
Distilling,—Appa's for boiling &	Wm. Hoffmire,	San Francisco,	Cal.	31
——— Sea-water,—Appa's for	G. S. G. Spencer,	Boston,	Mass.	3
Ditching Machine,—Mole	Josiah Hodgson,	N. Michigan,	Ill.	24
Door Plate,—Index	Nathan Ames,	Saugus Center,	Mass.	31
Dough,—Rollers for Pressing	Rice & Hayward,	Providence,	R. I.	3
Dovetailing Machines,—Cutters	John Bell,	Harlem,	N. Y.	10
Drain Tiles,	E. W. Rowe,	Brewer,	Me.	3
Dredging Apparatus,	T. A Bryan,	Queenstown,	Md.	6
Drills,—Ratchet	L. R. Billard,	Norfolk,	Va.	31
———,—Rock	Cushman & French,	N. Bloomfield,	Cal.	3
Drilling Machines,—Rock	Francis Schwalm,	Joliet,	Ill.	3
Engraving Copper Cylinders,	B. L. Philips,	Providence,	R. I.	3
Excavating Machines,	G. S. Manning,	Springfield,	Ill.	17
——— & Grading Machine,	P. T. Mayne,	Keosauqua,	Iowa,	17
Fan Blowers,	Henry Sweetapple,	Napa,	Cal.	31
Fares,—Machine for Registering	M. W. Helton,	Bloomington,	Ind.	24
Fats,—Machines for Cutting	W. E. Boulger,	Janesville,	Wis.	3
———,—Appa's for Rendering	Tompert & Coyle,	Louisville,	Ky.	3
Faucets,	James Flattery,	Brooklyn,	N. Y.	24
Felly Machine,	F. W. Mallett,	New Haven,	Conn.	17
Fence Posts,—Socket for	Blood & Miller,	Newport,	N. H.	3
——— Rails,—	Christian Yost,	Intercourse,	Penna.	3
Fences,—Portable	W. M. Wallace,	Cameron,	Ill.	3
Files,—Machines for Cutting	Etienne Bernot,	Paris,	France,	24
———	J. C. Cook,	Middletown,	Conn.	10
Filters,	John Fitch,	Seneca Falls,	N. Y.	10
Fire,—Protecting Buildings	S. M. Andrus,	Bellevue,	Mich.	10
Fire Arms,—Breech-loading	M. J. Gallager,	Savannah,	Ga.	17
———	R. F. Cook,	Potsdam,	N. Y.	24
———,—Revolving	Ethan Allen,	Worcester,	Mass.	3
———	C. R. Alsop,	Middletown,	Conn.	17
———	A. J. Gibson,	Worcester,	Mass.	10
Fire-place and Chimney,	Daniel Hemingway,	Covington,	Ky.	17
Fire Pokers,	G. R Moore,	Pittsburgh,	Penna.	24
Flour Chest,	I. R. Shank,	Buffalo,	Va.	24
Flower Stands,	H. J. Coster,	Chicago,	Ill.	17
Fluting Apparatus,	G. B. Arnold & others,	City of	N. Y.	24
Fly Trap,	H. H. Robertson,	Kingston,	Mo.	3
Food,—Preserving	W. A. Keeler,	City of	N. Y.	31
Foot-cleaner,	Shaler & Rogers,	Madison,	Conn.	31
Fruit-drying Apparatuses,	A. C. Lewis,	Burlington,	Mich.	31
Friction Wires,—Making	D. J. Ferry,	Philadelphia,	Penna.	24
Furnaces,—Air	Keller & Young,	Cincinnati,	Ohio,	17
———,—Hot-air	Ernst & Shepard,	Milwaukie,	Wis.	17
Garments,—Fastening for	C. W. Baldwin,	Boston,	Mass.	3
Gas,—Apparatus for Generating	Alexander Schwaninger,	Milwaukie,	Wis.	24
——— Generators,	C. N. Tyler,	Washington,	D. C.	24
——— Meters,	John Schatt,	Philadelphia,	Penna.	24

Gas Pipes,	Wm. Stephenson,	Galion,	Ohio,	10
—— and Water Pipe Joint,	C. W. Isbell,	New Haven,	Conn.	24
—— Regulators,	Thos. & Chas. Champion,	Washington,	D. C.	24
———— for R. R. Cars,	A. H. Phillippi,	Reading,	Penna.	31
—— Tubes,—Flexible Joints	Anthony Stratton,	Brooklyn,	N. Y.	10
Gates,	G. E. Baker,	Waukegan,	Ill.	24
Gear of Vehicles,	Richard Murdoch,	Baltimore,	Md.	10
Glass,—Manufacture of	Horace Trumbull,	Jersey City,	N. J.	3
—— Furnaces,	J. B. Hay,	Winslow,	"	24
—— Goblets,—Moulds for	A. J. Sweeney,	Wheeling,	Va.	3
Globes,	James Monteith,	City of	N. Y.	24
——,—School,	J. R. Agnew,	Philadelphia,	Penna.	24
————,—Suspending	James Monteith,	City of	N. Y.	24
Grain Binders,	J. S. Hickey,	Pike,	Ill.	17
————	Thomas Courser,	Princeton,	"	10
—— Cradles,	E. D. Wilcox,	Billingham,	Mass.	24
—— Separators,	George Arrowsmith,	Lockport,	N. Y.	10
————	Cornelius Bergen,	Farmer,	"	31
————	Thomas Earhart,	Donelson,	Tenn.	24
————	John C. Gregg,	Hillsboro',	Ohio,	17
————	A. J. Vandergrift,	St. Louis,	Mo.	24
————,—Governor	L. D. Lane,	Freeport,	Ill.	17
——,—Scouring & Separat'g	Matthew Bartholomew,	Enterprise,	Penna.	24
——,—Threshing & Cleaning	Ira Hart,	Clarksburg,	Va.	31
—— Winnowing Machines,	Bean & Wright,	Hudson,	Mich.	24
Grate,—Furnace	C. F. Cory,	Lebanon,	Ill.	24
Grates,—Stove	D. H. Nation,	Albany,	N. Y.	24
——,—— and Furnace	John V. B. Carter,	"	"	24
Gridiron,	Brooks & Grover,	Rochester,	"	24
Grindstones,—Center for Shaft	David Hinman,	Berea,	Ohio,	31
Handle to Picks, &c.,	J. H Fisher,	Placerville,	Cal.	17
Harmoneons,	H. W. Smith,	Boston,	Mass.	3
Harness Buckle,	J. W. Covel,	Bangor,	Me.	31
Harrows,	L. C. Gillespie,	Denmark,	Tenn.	10
Harvesters,	C. B. Brinckerhoff,	Batavia,	N. Y.	10
————	B. A. Jenkins,	Whitewater,	Wis.	10
———— of corn & sugar-cane,	G. W. N. Yost,	Cincinnati,	Ohio,	10
Harvesting Machines,	J. N. Bowman,	Brockport,	N. Y.	10
————	J. H. Rible,	Somerset,	Ohio,	10
————	Wm. Wilmington,	Toledo,	"	3
Hat Bodies,—Forming	Platt & Wildman,	Danbury,	Conn.	31
—— Ventilators,	F. H. Bell,	Washington,	D. C.	10
Hay Racks for Carts,	H. R. Hawkins,	Akron,	Ohio,	10
——,—Teeth for Scattering	J. C. Stoddard,	Worcester,	Mass.	24
Hemp Brakes,	E. W. Lacy,	Oak Park,	Va.	31
Hides,—Preparing	A. D. Lufkin,	Cleveland,	Ohio,	31
Hinges,—Spring	Abram Acker,	Ramapo,	N. Y.	17
Hoisting Apparatuses,	John Lemman,	Cincinnati,	Ohio,	17
Hominy Machines,	John Gehr,	Clear Spring,	Md.	17
Hook,—Mousing	Hjalmar Wynblad,	W. Hoboken,	N. J.	3
Horse Collars,	C. J. Fisher,	Wawkou,	Iowa,	17
Horse-shoe Machine,	Joseph Desnos,	Troy,	N. Y.	31
Horses,—Shoeing	G. R. Stevens,	Clarksville,	Mo.	3
Horse-shoes,—Making	H. A. Wills,	Keeseville,	N. Y.	3
Horse-stalls,—Attachment of	D. S. Neal,	Lynn,	Mass.	24
Horses from Cribbing,	Bishop & Low,	Warren,	"	31
———— Fire,—Rescuing	Elisha French,	Braintree,	"	31
———— Vehicles,—Detach'g	A. B. Johnson & others,	Clarksville,	Mo.	3
————————	J. M. Roberds,	Plaisance,	La.	24
Hot Water Apparatuses,	Henry Humphreyville, Jr.,	Strasburg,	Penna.	24
Ice-breaker,	C. W. Chapman,	Hartford,	Conn.	3
Ice-pick,	J. T. Van Kirk,	Philadelphia,	Penna.	17

Lamps,	James Adair,	Pittsburgh,	Penna.	31
———	Wm. Fulton,	Cranberry,	N. J.	24
———	Sumner Sargent,	Watertown,	Mass.	24
———	John Schley,	Savannah,	Ga.	24
———	I. W. Taber,	New Bedford,	Mass.	17
———	J. T. Van Kirk,	Philadelphia,	Penna.	17
——— for Locomotives,	James Radley,	City of	N. Y.	31
———,—Mica Chimney for	J. Y. Humphreys,	Philadelphia,	Penna.	17
———,—Vapor	Erastus Crooker,	Buffalo,	N. Y.	10
———————	I. Van Bunschoten	City of	"	31
Lathe,	Milton Roberts,	Worcester,	Mass.	10
Lath Machine,	R. J. Gatling,	Indianapolis,	Ind.	10
Leather,—Machs. for Crimping	Horace Wing,	Buffalo,	N. Y.	31
————,—Skiving	W. S. Williams,	Lynn,	Mass.	31
Lemon-squeezer,	L. S. Chichester,	City of	N. Y.	3
Lightning-rods,—Construction	J. M. Patterson,	Woodbury,	N. J.	31
Lights for Ships,—Side	Enoch Hidden,	City of	N. Y.	10
——,—Street	J H. Kalb,	Charleston,	S. C.	31
Lock,	C. E. Brown,	Bridgeport,	Conn.	10
Locks,—Door	Calvin Adams,	Pittsburgh,	Penna.	3
Locomotive Engines,—Exhaust	John Dykeman,	Greenbush,	N. Y.	3
Looms,	L. R. Wattles,	Newton,	Mass.	31
———,—Pattern Chain for	B. H. Jenks,	Philadelphia,	Penna.	24
Lubricating Compound,	Radspinner & Moss,	N. Richmond,	Ohio,	3
———— Pistons,	Benjamin Garvey,	City of	N. Y.	17
———— Purposes,—Compo.	C. Chitterling,	Dunkirk,	"	24
Mattress and Bed,	F. Elder,	Winnsboro',	S. C.	10
Meat-cutter,	Louis Bonnet,	City of	N. Y.	24
————	J. G. Perry,	S. Kingston,	R. I.	31
Meat-cutters,—Cylinders for	S. R. Plumb,	Southington,	Conn.	31
Melodeons,	S. H. Jones,	Jamaica Plains,	Mass.	3
————	C. J. Van Oeckelen,	City of	N. Y.	3
Mills,	Wm. Joslin,	Cleveland,	Ohio,	3
——	A. H. Wagner,	Staunton,	Va.	31
Mill Bushes,	J. G. Shafer,	Fulton co.,	Penna.	3
Mills,—Corn and Cob	S. A. Briggs,	Philadelphia,	"	3
Millstones,—Dressing	M. H. Bacon,	Mystic,	Conn.	10
———————	"	"	"	31
———————	G. Z. Hockenburry,	Pittsburgh,	Penna.	24
———————	Martin Shirk,	Lancaster co.,	"	24
Mills,—Grinding	Ruof, Heupel, & Leuthy,	"	"	3
Mop Head,	James Doty, Jr.,	West Falls,	N. Y.	17
Mortising Machine,	Eleazar Coffin,	Indianapolis,	Ind.	17
Motion to Machinery,—Transf.	Wm. Phelps,	Sycamore,	Ill.	3
Motive Power,	Towsley & Matteson,	City of	N. Y.	24
—————,—Obtaining	Jacob Pringle,	Summer Hill,	Penna.	24
—————,—Steam for	J. W. Durham,	Durhamville,	Tenn.	17
Mowing Machines,	A. B. Allen,	City of	N. Y.	24
——————	Frederic Gardiner,	Gardiner,	Me.	31
——————	J. W. Shipman,	Springfield Cen.	N. Y.	24
——————	F. W. Warner,	E. Haddam,	Conn.	31
Needle Threaders,—Casting	S. S. Burlingame,	Warwick,	R. I.	24
Nail Brush,	Wm. Thomson,	Buffalo,	N. Y.	31
Odometers,	A. T. Howard,	Hartford,	Vt.	3
Oil Cans,	James Jackson, Jr.,	Westerly,	R. I.	31
——,—Distillation of Coal	Benjamin Garvey,	City of	N. Y.	17
—— Feeder,	Joshua Turner,	Cambridgeport,	Mass.	31
Oils,—Fish	Wm. D. Hall,	Hamden,	Conn.	17
Ordnance,—Projectiles for	B. B. Hotchkiss,	Sharon,	"	24
————,—Repeating	J. A. Matthews,	St. Louis,	Mo.	31

Ore Separator,	Samuel Man,	Chicago,	Ill.	31
———————	E. L. Seymour,	City of	N. Y.	17
Paint Can,	J. W. Masury,	City of	N. Y.	10
Padlock,	Roos & Spoehr,	"	"	31
Paper Pulp,—Manufacture of	Ebenezer Clemo,	Toronto,	C. W.	10
Pawl and Ratchet,	E P. Russel,	Manlius,	N. Y.	24
Pegging Jacks,	Ephraim Everson,	Haverhill,	Mass.	24
———————	E. L. Harlow,	Monmouth,	Me.	31
Pen and Pencil Case,	G. E. Frew,	Brooklyn,	N. Y.	31
——— Holder,	Jonathan Warren,	"	"	31
Photographic Paper,—Silvering	Thompson & Wheaton,	City of	"	31
Piano-fortes,	J. U. Fischer,	"	"	10
———————	G. H. Hulskamp,	Troy,	"	10
Piano-forte Action,	F. W. Niehaus,	Boston,	Mass.	3
Pianos,—Bridges for	Wm. Compton,	City of	N. Y.	10
———,—Tuning	J. B. Morris,	Berryville,	Va.	3
Picture Frames,—Enameling	John Sperry,	City of	N. Y.	10
Pins,—Manufacture of	T. and De G. Fowler,	Northford,	Conn.	31
Planing Machine,	Benaiah Fitts,	Worcester,	Mass.	31
—————————	W N. Manning,	Salem,	"	17
Plotting Instrument,	Samuel Barnett,	Washington,	Ga.	17
Ploughs,	E. B. Clark,	Tallahassee,	Fla.	17
———	Wm. Griffin,	Bennettsville,	S. C.	3
———	Loure Green,	Great Bend,	Penna.	17
———	M. C. McCullers,	Herndon,	Ga.	17
———	H. H. Robertson,	Kingston,	Mo.	10
———,—Ditching	James Brooks,	Romulus,	N. Y.	31
———————,—Capstans	Elias Forbes,	London,	Ohio,	24
———,—Gang	T. S. Heptinstall,	Mendota,	Ill.	17
——————	J. C. Wilson,	Cedar Hill,	Texas,	3
———,—Mole	A. M. Karr,	Mt. Pleasant,	Iowa,	24
——————	C. W. Stafford,	Burlington,	"	24
———,—Steam	T. H. Burridge,	St. Louis,	Mo.	31
Polishing Cabinet-work,	J. B. Morris,	Ansonia,	Conn.	24
Potatoes,—Covering	H. L. Bennett,	Long Branch,	N. J.	31
Potato-diggers,	G. C. Bartlett,	Paris,	N. Y.	24
——————	Daniel De Garmo,	Rochester,	"	24
Potato-parer,	Charles Disston,	Philadelphia,	Penna.	3
Presses,—Cotton	Henry Mason,	Lancaster,	Mass.	24
———,——— and Hay	H. F. Hicks,	Grand View,	Ind.	24
———,—Hay	I. S. Arnold,	South Milan,	"	3
——————	S. G. Randall,	N. Britain,	Conn.	17
——————	Sylvester Stevens,	Sacramento,	Cal.	24
Prisons,—Iron,	E. Jacobs,	Cincinnati,	Ohio,	24
Propellers,—Rocking	Edward Landis,	Baltimore,	Md.	24
Pumps,	Birdsill Holly,	Lockport,	Ill.	24
———	J. A. C. J. Smith,	Philadelphia,	Penna.	10
———	Chapman Warner,	Brooklyn,	N. Y.	31
——— for Locomotive Engines,	C. L. Rice,	Milwaukie,	Wis.	17
Punching Machines,	Bradshaw & Coley,	Lowell,	Mass.	24
————————	Chas. Hughes,	N. Orleans,	La.	24
Quartz-crushing Apparatus,	Celestino Dominguez,	San Francisco,	Cal.	3
Railroad Bolts,—Fastening Nuts	G. W. R. Bayley,	Brashear,	La.	24
———— Cars,—Couches for	Wm. A. Brown,	Philadelphia,	Penna.	17
————————,—Dumping	A. B. Cooley,	"	"	3
————————,—Journal Box	Josiah Ashenfelder,	"	"	31
————————,—Seal Lock for	J. H. Lyon,	City of	N. Y.	17
————————,—Stop. & Start.	E. S. Ritchie,	Brookline,	Mass.	3
———— Cattle Car,	J. B. Shafer,	Grafton,	Va.	31
———— Gates,	Lester Butler,	Kenosha,	Wis.	17
———————	McNair & Elliott,	Augusta co.,	Va.	17

Railroad Switches,	J. C. Whitson,	Marion,	N. C.	17
Rakes,—Horse	Wm. & Thos. Schnebly,	Hackensack,	N. J.	10
——— ———	Seidle & Eberly,	Mechanicsb'gh,	Penna.	3
———,—Horse Hay	A. R. Hurst,	Chambersburg,	"	10
Rat Traps,	Leonard Parker,	Winterset,	Iowa,	17
Refrigerator,	W. W. Stannard,	Buffalo,	N. Y.	31
Register Point,	J. W. Cliff,	Rochester,	"	31
Roofing, Belting, &c.,—Fabric	J. B. Wands,	Memphis,	Tenn.	31
——— and Cement,—Comp.	Alexander Asboth,	City of	N. Y.	3
Rotary Engines,	S. T. Russell,	Ottawa,	Ill.	31
Sash-fastener,	T. L. Braynard,	City of	N. Y.	24
——— ———	Julius Hornig,	Newark,	N. J.	24
Sash Stops to Windows,	N. L. McFarlan,	Syracuse,	N. Y.	3
Sausage-stuffer,	Jacob Kinzer,	Pittsburgh,	Penna.	31
Sawing Bevels on Laths,	G. W. Corson,	Corson's P. O.	"	10
——— Boards,—Machine for	Timothy Drake,	Windsor,	Conn.	3
——— Machine,	Carey Pitts,	Troy,	N. Y.	3
———,—S'm cross-cut	S. M. King,	Lancaster,	Penna.	31
——— Staves,—Machine for	H. H. Evarts,	Chicago,	Ill.	10
——— ———	W. W. and J. B. Hurlbut,	"	"	3
Saws,—Straining Scroll	Chas. Rose,	Allentown,	Penna.	3
Saw-mills,	G. H. Clemens,	Cincinnati,	Ohio,	10
Staves,—Machine for Jointing	J. F. & I. W. Bristow,	Vevay,	Ind.	3
Scaffolds,—Supporting	J. K. Lewis,	Rising Sun,	"	10
Scissors,	J. G. DeCoursey,	Philadelphia,	Penna.	24
Screw Wrenches,—Heading	L. and A. G. Coes,	Worcester,	Mass.	31
Screws,—Making	Justus Griggs,	Utica,	N. Y.	31
Seed Planters,	G. T. Bennett,	Mt. Olive,	N. C.	17
——— ———	George Hetrick,	Reidsburg,	Penna.	10
Seeding Machines,	G. W. Clark,	Mt. Washington	Ohio,	10
——— ———	Ezra Emmert,	Franklin Grove,	Ill.	10
——— ———	J. S. Gage,	Dowagiac,	Mich.	10
——— ———	Hermann Kaller,	Perry,	Ill.	17
——— ———	W. P. Penn,	Belleville,	"	17
——— ———	Edwin Ritson,	Sanbornton,	N. H.	10
——— ———	D. J. Vail,	Industry,	Ill.	31
Segars,	Isaac Lindsley,	Providence,	R. I.	31
Sewing Machines,	Ezekiel Booth,	Troy,	N. Y.	3
——— ———	John First,	City of	"	3
——— ———	W. C. Hicks,	Boston,	Mass.	24
——— ———	Hugo Mueller,	City of	N. Y.	3
——— ———	J. S. McCurdy,	Brooklyn,	"	3
——— ———	Penny & Botsford,	Wooster,	Ohio,	3
——— ———	W. A. Sutton,	City of	N. Y.	17
——— ———	C. H. Willcox,	"	"	31
——— ———,—Shuttles	Planer & Siegl,	"	"	17
——— ———,—Spool Pins	George Churchill,	Hartford,	Conn.	17
Ships Boats,—Lowering, &c.,	J. A. Davis,	Portsmouth,	Va.	10
—— Rigging,—Setting-up	E. U. Thompson,	Bristol,	Me.	17
Shoemakers Last,	J. C. Plumer,	Portland,	"	17
Shovels,	J. U. Fiester,	Winchester,	Ohio,	17
Signal Lantern,	T. F. Woodward,	S. Reading,	Mass.	10
Silk in the Hank,—Stretching	Lucius Dimock,	Hebron,	Conn.	17
Skates,	Jeremiah Heath,	Providence,	R. I.	3
———	L. and I. J. White,	Buffalo,	N. Y.	10
Smoothing-irons,—Heating	J. E. Johnson,	Brockport,	"	31
——— ———,—Self-heating	B. O. Ball,	Greensburgh,	Ohio,	10
Smut Machines,	Drake & Hewett,	Marshall,	Mich.	31
——— ———	Samuel Favinger,	Philadelphia,	Penna.	17
——— ———	Richard Mohler,	Lancaster,	"	24
Soldering Irons,	Lester Patee,	Peoria,	Ill.	3
Springs,—Adjustable Carriage	George Palmer,	Littlestown,	Penna.	24

Springs,—Car	McCormick & Jerrold,	Paterson,	N. J.	17
Spring,—Compensating Lever	Wm. S. Pratt,	Williamsburgh,	N. Y.	24
Spoke Machine,	S. B. Wilkins,	Milton,	Penna.	10
Stamping Heads,—Casting	P. W. Gates,	Chicago,	Ill.	31
Stave Machine,	W. M. Sloan,	Buffalo,	N. Y.	17
Stave-jointing Machines,	C. M. Young,	Sinclairsville,	"	31
Steam Boilers,	Bean & Collins,	Manchester,	N. H.	3
———	J. H. Boardman,	City of	N. Y.	31
———	John Brown,	"	"	24
———	Jonathan Vaile,	Miami,	Ohio,	24
———,—Alarm Gauge	C. T. Pangborn,	Brooklyn,	N. Y.	24
———,—Feeding Appar.	Thomas Shaw,	Philadelphia,	Penna.	31
———,—Fusible Plugs	I. C. Saunders,	Trenton,	Mich.	24
———,—Low-water Det.	J. W. Hopper,	City of	N. Y.	24
———,—Valves for	D. R. Prindle,	E. Bethany,	"	3
——— Engines,	W. Birkbeck,	Jersey City,	N. J.	3
———,—Boiler-feeders	E. A. Wood,	Utica,	N. Y.	3
———,—Governors for	Jerome Wheelock,	Worcester,	Mass.	3
———,—Pumps for	J. F. Hamilton,	Pittsburgh,	Penna.	24
——— Generator	Benjamin Garvey,	City of	N. Y.	17
——— Land Carriages,	C. H. Baker,	Red Wing,	Minn.	3
——— Pressure Gauge,	Wm. P. Parrott,	Boston,	Mass.	24
Steering Apparatus.	E. W. Tarbell,	"	"	31
——— Vessels,—Mode of	F. E. Sickles,	City of	N. Y.	17
Stereotype Plates,—Making	S. H. Mix,	Schoharie,	"	10
Stone-dressing Machines,	Francis Schwalm,	Joliet,	Ill.	10
Stone,—Machine for Crushing	G. A. Rollins,	Nashua,	N. H.	17
Stoves,	Charles Jones,	Philadelphia,	Penna.	17
———	S. H. Ransom,	Albany,	N. Y.	24
———,—Coal	Lucius Crandall,	Plainfield,	N. J.	24
———,—Cooking	Cavanaugh & Lazear,	Jersey City,	"	24
———	Johnson & Wansbraugh,	Cincinnati,	Ohio,	31
Stove-pipes,—Machine for Form.	James Rogers,	Sa. Clara co..	Cal.	31
Straw Cutters,	Samuel Ring,	Cleveland,	Ohio,	24
——— and Stalk Cutters,	Preston, Jr., & Farnham,	Corning,	N. Y.	31
Submarine Operator,	G. W. Martin,	W. Morrisania,	"	24
Sugar,—Appar. for Draining	J. J. Unbehagen,	Baton Rouge,	La.	10
——— Cane,—Wind-rowing	B. A. Jenkins,	Whitewater,	Wis.	3
——— Kettle Trains,	J. P. Henderson,	Franklin,	La.	10
Surveyors Tackle Case,	W. H. Paine,	Sheboygan,	Wis.	10
Sweeping Streets,—Machine for	G. M. Ramsay,	City of	N. Y.	10
Switch Plates for City R. R.s,	Wm. Ebbitt,	"	"	24
Syringes,	Benjamin Irving,	"	"	10
———	E. G. Stevens,	Biddeford,	Me.	10
Tanning,—Compounds for	D J. Cochran,	Centerville,	Ind.	17
——— Extracts,	James Connell,	Port Huron,	Mich.	17
Telegraphic Repeaters,	J. J. Clark,	Philadelphia,	Penna.	24
Thills to Vehicles,—Attaching	L. C. Miner,	Hartford,	Conn.	17
Thread-polishing Machines,	L. C Ives,	"	"	17
Threshing Machines,	W. W. Dingee,	York,	Penna.	24
———	S. E. Oviatt,	Richfield,	Ohio,	10
——— Peas and Beans,	J. T. Smith,	Portsmouth,	Va.	24
Timber,—Comp. for Preservation	John Dain,	Utica,	Ohio,	31
Tobacco Boxes,	Friedrick & Walter,	City of	N. Y.	17
———	Henry Kurth & others,	Brooklyn,	"	31
———,—Pressing	John Henry,	Lynchburgh,	Va.	24
Tool Sharpener,—Edge	S. W. Wood,	Watertown,	N. Y.	24
Trees,—Machine for Felling	A. P. Torrence,	Oxford,	Ga.	3
——— from Insects,—Protecting	Nathaniel Potter, Jr.,	S. Dartmouth,	Mass.	10
Trusses,	Henry Dalton,	City of	N Y.	3
———,—Belt	J. C. Rainbow,	New Brighton,	Penna.	31
———,—Hernial Spring	D. L. D. Sheldon,	San Francisco,	Cal.	31

Tubes,—Aesophagus,	N. Q. Munger,	Brookfield cen.	Wis.	10
——,—Forming Seamless	C. E. L. Holmes,	Waterbury,	Conn.	24
Tweers,	Tolman & Blodget,	N. Orange,	Mass.	10
Type-metal with Brass,—Coat'g	Joseph Corduan,	Brooklyn,	N. Y.	17
Varnish,—Polishing	Bennett & Stover,	Boston,	Mass.	3
Vermin,—Appar. for Destroying	Levi Disbrow,	Oswego,	N. Y.	31
Vinegar,—Manufacture of	F. M. Ruschhaupt,	City of	"	31
Warming Apparatus,	J. H. Davis,	Woburn,	Mass.	31
Washing Machine,	John Contrell,	City of	N. Y.	10
————	Wm. Gowen	Wausau,	Wis.	17
————	A. B. Harlan,	Ercildoun,	Penna.	17
————	S. T. Vallett,	Providence,	R. I.	3
Watches.	O. H. Woodworth,	Coffeeville,	Miss.	17
Watch Chains,—Hooks for	J. R. Lounsberry,	N. Eng. Village,	Mass.	10
Watchmakers Lathes,	Albert Wild,	City of	N. Y.	17
Water Closet,—Portable	Enoch Hidden,	"	"	24
Water,—Method of Cooling	Thomas Byrne,	Baton Rouge,	La.	10
—— Metres,	Gerard Sickles,	Roxbury,	Mass.	24
—— Pipes to Buildings,	Wm. Austin,	Philadelphia,	Penna.	3
—— Wheels,	Closs & Pyle,	Decatur,	Ind.	10
————	Henry Fellows,	Bloomfield,	"	24
————	James Martin,	Florence,	Ala.	3
————	J. M. Perkins,	Chicago,	Ill.	24
————	J. W. Truax,	Richford,	Vt.	24
Wheels,—Adjusting Tire on	W. S. Harrison,	Carson's Land.	Miss.	3
—— for Gun Carriages, &c.,	C. F. Brown,	Warren,	R. I.	10
Whiffle-trees for Vehicles,	Ignaz Ramminger,	City of	N. Y.	17
Windmills,	Arnold De Witt,	Brooklyn	"	3
————	Henry Glover,	E. Douglas,	Mass.	10
Windows,—Appar. for Cleaning	George Munce,	St. Louis,	Mo.	31
Window Sashes,—Elevator for	Samuel Mills,	City of	N. Y.	31
—— Stop and Fastening,	Turner Williams,	Providence,	R. I.	17
Wrench,	R. P. Buttles,	Mansfield,	Penna.	3
Yokes,—Bow of Ox	Warren & Silliman,	Chester,	Conn.	17

EXTENSIONS.

Horse-powers,	Sheldon & Cary,	Chili,	N. Y.	3
Looms,	W. D. Dutcher,	Milford,	Mass.	3
Netting Machines,	John McMullen,	Baltimore,	Md.	3

ADDITIONAL IMPROVEMENTS.

Altitudes of the Sun,—Taking	Frederick Yeiser,	Indianapolis,	Ind.	17
Clover Hullers,	Anthony Overocker	McHenry,	Ill.	24
Grates,	Joseph Tiberi,	St. Louis,	Mo.	17
Railroad Cars,—Roofs for	A. P. Winslow,	Cleveland,	Ohio,	31
Shoe Heels,—Cutting & Finish.	W. F. Edson,	Philadelphia,	Penna.	24

RE-ISSUES.

Air Engines,	Philander Shaw,	Boston,	Mass.	17
Artificial Legs,	Douglas Bly,	Rochester,	N. Y.	3
Bedsteads,—Folding	T. B. Bleecker,	City of	"	24
Canal Boats,—Paddle Wheels	Reuben Jane,	Otego,	"	3
Fences,—Panels of Portable	Chas. Van DeMark,	Oak Corners,	"	10
Gas Regulators,	Salmon Bidwell,	City of	N. Y.	31
Grain Separators & Cleaners,	W. M. Arnall,	Sperryville,	Va.	10
————,—Shoe for	Hiram Aldridge,	Michigan City,	Ind.	31
Harvesters and Binders (2 pats.),	H. Baldwin, Jr.,	Washington,	D. C.	3
Mowing Machines (7 patents),	Ephraim Ball,	Canton,	Ohio,	17
Oilcloth,—Printing 2 "	James Albro,	Elizabeth,	N. J.	3
Paper Pulp,—Manu. 2 "	Palser & Howland,	Ft. Edward,	N. Y.	3
Photo-lithography,	Cutting & Bradford,	Boston,	Mass.	31

Printing Presses (2 patents),	G. P. Gordon,	City of	N. Y.	31
Reaping Machines, 3 "	W. H. Seymour,	Brockport,	"	10
Saw-mills—Circular	N. G. Norcross,	Lowell,	Mass.	10
Seeding Machines,	A. E. Bonham,	Elizabethtown,	Ohio,	10
Steam Boilers.—Feed-water	G. W. Rains,	Newburgh,	N. Y.	24
Windlasses,—Ships	Wm. H. Gilmore,	Worcester,	Mass.	31
DESIGNS.				
Gridiron,	Elnathan Peck,	New Britain,	Conn.	17
Hub Bands,	B. S. Pardee,	Mt. Carmel,	"	31
Range,—Cooking	Sanders & Vedder,	City of	N. Y.	31
Spoon Handles,	H. C. Foster,	Worcester,	Mass.	3
Stove,	Isaac DeZouche,	St. Louis,	Mo.	3
——,—Coal	Daniel Hathaway,	Troy,	N. Y.	31
——,—Cook's	W. W. Stanard,	Buffalo,	"	24
———— (4 patents),	G. Smith & H. Brown,	Philadelphia,	Penna.	3
——,—Cooking (2 cases)	S. H. Ransom,	Albany,	N. Y.	3
———— "	W. W. Stanard,	Buffalo,	"	31
———— "	G. Smith & H. Brown,	Philadelphia,	Penna.	3
————	N. S. Vedder,	Troy,	N. Y.	31
——,—Parlor	S. H. Ransom,	Albany,	"	3
————	W. W. Stanard,	Buffalo,	"	31
——,—Six-plate	Daniel Hathaway,	Troy,	"	31
——,—Plates of a Cook's	G. Smith & H. Brown,	Philadelphia,	Penna.	17
Trade Mark,	D. L. Meineke,	St. Louis,	Mo.	31

FRANKLIN INSTITUTE.

Proceedings of the Stated Monthly Meeting, September 20, 1860.

John C. Cresson, President, in the chair.

John Agnew, Vice-President,
Isaac B. Garrigues, Recording Secretary, } Present.

The minutes of the last meeting were read and approved.

Donations to the Library were received from la Société Industrielle de Mulhouse, France; the Hon. P. F. Thomas, Commissioner of Patents, and Frederick Emerick, Esq., Washington, D. C.; the Massachusetts Charitable Mechanics Association, Boston, Mass.; Thomas Ewbank, Esq., and Dr. Martyn Paine, City of New York; the Wilmington Institute, and Edward Tatnell, Esq., Wilmington, Del.; the Maryland Institute, Baltimore, Md.; John A. Roebling, Esq., Trenton, N. J.; Dr. Charles M. Wetherill, Lafayette, Ind.; the Harrisburgh, Portsmouth, Mountjoy, and Lancaster Railroad Co., Messrs. Moses Thomas & Sons, and Prof. John F. Frazer, Philadelphia.

The Periodicals received in exchange for the Journal of the Institute, were laid on the table.

The Treasurer's statement of the receipts and payments for the month of August was read.

The Board of Managers and Standing Committees reported their minutes.

Candidates for membership in the Institute (9) were proposed, and the candidates proposed at the last meeting (12) duly elected.

Mr. Howson exhibited a collection of fire arms manufactured by

Christian Sharps, Esq., (the well-known inventor of Sharps' rifle,) at his establishment in West Philadelphia.

The first arm exhibited was a specimen of the standard military carbine, arranged to load at the breech, and having the patent self-priming device. This arm was manufactured in New England from Mr. Sharps' designs, and is, in most respects, similar to those made for the United States, as well as for several European governments. It has, however, an improvement in the self-priming arrangement, whereby the magazine of caps may be reserved for emergencies, and caps of ordinary construction used.

Two beautiful specimens of light breech-loading rifles with barrels of smaller calibre than the above were next exhibited. These were arranged to receive a metallic case containing the charge of powder and ball; the case after being discharged is withdrawn from the breech to be again used after it has received a new charge. A suitable number of these cases are carried in a pouch by the sportsman, who recharges them at his leisure.

Several specimens of Sharps' patent breech-loading repeating pistol were exhibited and explained. This fire arm consists of a barrel block with four bores, the block being arranged to slide to and fro on the stock. A metallic cartridge is inserted into each bore, the block moved up to the stationary breech of the stock and there locked, when the fire arm is ready for being discharged. The hammer is provided with a revolving nipple which strikes each cartridge in succession, the movement of the nipple being effected by the cocking of the hammer.

Mr. Howson exhibited the several pieces of which one of these pistols was composed, in their crude state, remarking that each piece was reduced to its proper form by machinery, with an exactitude which no manipulation could accomplish, every portion of one pistol being an exact counterpart of the corresponding portions of another pistol; and that when the extent and beauty of the workmanship is considered, it is almost impossible to conceive how these weapons can be manufactured so rapidly as to be retailed for the low price of ten to twelve dollars; but that a visit to Mr. Sharps' factory, and an examination of the beautiful and effective tools there used, and a knowledge of the fact that subdivision of labor is there carried out to perfection, would solve the mystery.

Vast quantities of these arms are sent to all parts of the Union by Messrs. Handy & Brenner, of this city, the sole agents for the sale of Sharps' fire arms.

Mr. H. subsequently explained to the meeting Mr. Sharps' improvements in the construction of metallic cartridges, which are destined to replace the ordinary paper cases. These cartridges, first used in France, consist of thin metal cases, with an enlargement at one end for containing the detonating material, and a bullet at the opposite end; the interior of the case containing the charge of powder, and the cartridges being exploded by causing the hammer to strike the edge of the enlargement.

It is necessary, in order that the spent cartridges may be readily extracted from the bore of the barrel, that the cases should have a slight taper. In order to impart this taper to, and to form the enlargement on, a hollow metal cylinder closed at one end, Mr. Sharps uses a die composed of two steel blocks, in which is formed a chamber of the shape of the desired case. Into this chamber is dropped the hollow cylinder, the latter being subsequently partially filled with water. A plunger is now inserted into the mouth of the cylinder, and a smart blow imparted to it, thereby causing the metal to expand and adapt itself to the shape of the chamber; after which the now completed case is withdrawn from the dies.

By this contrivance, and others of equal simplicity and ingenuity for spreading the detonating material in the enlargement of the case and confining it therein, Mr. Sharps is enabled to make the most perfect metallic cartridges at the same cost as those made of paper.

It was remarked, in conclusion, that Mr. Sharps had devoted the greater part of his life to the experimenting with and the designing of improvements in fire arms and projectiles, and this with such success, that the superiority of his ware was universally acknowledged: many European regiments being armed with the celebrated Sharps' rifle.

Mr. Thomas E. McNeill exhibited a very beautiful and ingenious steam gauge invented and patented by Mr. J. E. Wootten. It consists of a steam chamber formed by riveting together at their edges two disks of very hard rolled sheet brass. The dilation of these disks under pressure, communicates motion to the index pointer, by means of a coarse threaded screw cut upon the spindle to which the pointer is attached. A hair spring is attached to the spindle for the purpose of keeping its point at all times in contact with the front disk, by which means, an accurate indication of pressure is obtained.

BIBLIOGRAPHICAL NOTICE.

The Manufacture of Vinegar: its Theory and Practice; with especial reference to the quick process. By Chas. M. Wetherill, Ph. D., M. D. Philadelphia: Lindsay & Blakiston, 1860. 12mo. pp. 300.

This is an excellent theoretical and practical treatise upon a subject which possesses great interest for every one, especially to those who, living at a distance from manufacturing centres, are here shown how easily and with how little expenditure of capital they may ensure for themselves purity and proper strength of an article of such domestic importance. But the book has another and perhaps higher value, as a type of what such a treatise should be; the clear precise statement of its facts, its logical method, and absence of all parade of unnecessary learning, are the exact qualifications which are necessary to make a treatise on the manufacture of any speciality useful and interesting; and if more of those who have heretofore professed to write such treatises had attended to this, we should have had our manufacturers and people much better informed upon such subjects than they now are.

We need not say to any one who reads this book, that its author is an excellent chemist; that is manifest as well by what he does not say as by what he does; but we take the opportunity of acknowledging the receipt of another investigation by him on the subject of the relative cost of light from different materials, which will be of great importance for the region of country in which he resides.

The book under consideration is very excellently got out by the well-known publishers, and is worthy of being read by all, and of being studied by all who are in any way interested in the manufacture of vinegar. F.

METEOROLOGY.

For the Journal of the Franklin Institute.

The Meteorology of Philadelphia. By James A. Kirkpatrick, A.M.

August.—The temperature of the month of August was a degree and a half below that of July last, about one degree above that of August, 1859, and about half a degree above the average temperature of August for the last ten years. It will be seen, by the table of comparisons given below, that this difference of temperature occurred principally at 2 o'clock in the afternoon, the means for 7 A. M. and 9 P. M., for 1860, being almost identical with those for the same hours for ten years; while the mean for 2 P. M., in 1860, was two degrees higher than the average for the same time.

The warmest day was the 5th, of which the mean temperature was 83°. The highest degree indicated by the thermometer was 95° on the 10th of the month; the mean temperature of that day was 82·7°. From the 4th till the 10th, the temperature did not fall below 70°, night or day. On the night of the 10th, however, rain fell, the wind changed from the south-west to the north-west, and, during the next day, the thermometer indicated an average fall of nearly 12°.

On the 13th a thunder-storm occurred. Rain fell in heavy showers all the morning; but about two o'clock in the afternoon the lightning became very vivid and the rain came down in torrents. In two hours, from two till four o'clock, three inches and thirty-five one-hundredths of an inch of rain fell—about four times as much as fell during the whole of the month of July. During the storm, a man was instantaneously killed by lightning in the southern part of the city. The rain continued heavy and steady until 11½ A. M., on the morning of the 14th.

The 14th was the coldest day of the month, the average temperature being 65°. The lowest degree indicated by the thermometer was 55° on the morning of the 15th.

The barometer was highest on the 16th, when it indicated a pressure equal to 30·026 inches; and lowest on the 25th, when it marked 29·632 inches. The average height of the barometer for the month was very nearly the same as for August, 1859, and but three-hundredths of an inch lower than the average for the last ten years.

On the 23d, a very heavy rain-storm passed over the northern portion of the city. It is said that, at Manayunk, over ten inches of rain fell; while, in the centre of the city, less than two-tenths of an inch was collected in the rain-gauge.

The whole amount of rain that fell during the month was nine inches and twenty-six hundredths of an inch, which is a greater quantity than has fallen in the month of August for ten years. The nearest approach to it was in August, 1857, when a little over eight inches (8·039) fell. The average amount for this month is 4·714 inches.

There were five days of the month entirely clear, and two on which the sky was completely covered with clouds at the hours of observation.

A Comparison of some of the Meteorological Phenomena of August, 1860, *with those of August,* 1859, *and of the same month for ten years, at Philadelphia.*

	Aug., 1860.	Aug., 1859.	Aug., 10 years.
Thermometer.—Highest, . .	95°	97°	97°
“ Lowest, . .	55	51½	47
“ Daily oscillation,	18·80	20·50	15·90
“ Mean daily range,	3·80	3·10	3·80
“ Means at 7 A. M.,	70·13	69·03	70·29
“ “ 2 P. M.,	82·87	82·16	80·74
“ “ 9 P. M.,	73·29	72·39	73·37
“ “ for the month,	75·43	74·53	74·80
Barometer.—Highest, . .	30·026 in.	29·998 in.	30·255 in.
“ Lowest, . . .	29·632	29·671	29·356
“ Mean daily range, .	·090	·070	·092
“ Means at 7 A. M., .	29·848	29·847	29·879
“ “ 2 P. M., .	29·813	29·801	29·851
“ “ 9 P. M., .	29·834	29·832	29·869
“ “ for the month,	29·832	29·827	29·866
Force of Vapor.—Means at 7 A. M.,	·580 in.	·551 in.	·584 in.
“ “ “ 2 P. M.,	·584	·551	·596
“ “ “ 9 P. M.,	·603	·581	·613
Relative Humidity.—Means at 7 A. M.,	77 per ct.	75 per ct.	77 per ct.
“ “ “ 2 P. M.,	52	50	56
“ “ “ 9 P. M.,	73	72	74
Rain, amount in inches, . .	9·260	4·447	4·714
Number of days on which rain fell, .	13	8	10
Prevailing winds, . . .	N.80°54′W·150	S.26°34′E.·055	S.83°35′W·104

SUMMER.—The meteorological summer, consisting of the months of June, July, and August, was, during this year, distinguished by many interesting phenomena which have been particularly noticed in the reports for the separate months. The eclipse of the sun, the extraordinary meteor of the 20th of July, the heated wind storms of Kansas and throughout the South-West, the unusually great number of thunder-storms, and the destructive tornados in several of the Western States, will make the summer of 1860 a memorable one. But few of these storms reached Philadelphia, and those that did reach us seem to have spent their fury to a great degree before their arrival.

The pressure of the atmosphere was considerably less than the average, as will be seen by reference to the table of comparisons.

The temperature was intermediate between that of the summer of 1859, and the average for the nine past summers, being about three-quarters of a degree above the former, and the same quantity below the latter.

The force of vapor and relative humidity were both below the average.

The rain was half an inch more than fell in last summer, but nearly an inch more than the general average for the season. More than three-fourths of it, however, fell in the month of August.

The number of days on which rain fell was 33, being one more than usual.

The prevailing winds during this summer came from a point a little north of west, while their average direction for nine years is about twice as far south of west.

A Comparison of the Summer *of* 1860, *with that of* 1859, *and of the same season for nine years, at Philadelphia.*

	Summer, 1860.	Summer, 1859.	Summer, for 9 years.
Thermometer.—Highest,	95·5°	97°	100·5°
" Lowest,	52·0	42·0	42·0
" Daily oscillation,	19·20	19·90	16·10
" Mean daily range,	4·33	4·60	4·10
" Means at 7 A. M.,	70·11	69·36	71·20
" " 2 P. M.,	81·71	80·53	81·43
" " 9 P. M.,	72·23	71·48	74·01
" " for the summer,	74·68	73·79	75·55
Barometer.—Highest,	30·123 in.	30·202 in.	30·281 in.
" Lowest,	29·243	29·520	29·182
" Mean daily range,	·097	·095	·094
" Means at 7 A. M.,	29·805	29·866	29·859
" " 2 P. M.,	29·769	29·825	29·828
" " 9 P. M.,	29·789	29·848	29·844
" " for the summer,	29·788	29·847	29·844
Force of Vapor.—Means at 7 A. M.,	·529 in	·535 in.	·577 in.
" " " 2 P. M.,	·518	·555	·588
" " " 9 P. M.,	·547	·557	·607
Relative Humidity.—Means at 7 A. M.,	71 per ct.	72 per ct.	74 per ct.
" " " 2 P. M.,	48	52	55
" " " 9 P. M.,	68	71	71
Rain, amount in inches,	13·817 in.	13·591	12·979
Number of days on which rain fell,	33	31	32
Prevailing winds,	N.82°27′W·165	S. 73°8′W. ·182	S.74°27′W·159

Abstract of Meteorological Observations for July, 1860; *made in Philadelphia, Franklin, Indiana, and Armstrong Counties, Pennsylvania, for the Committee on Meteorology of the Franklin Institute.*

	PHILADELPHIA.—Lat. 39° 57′ 28″ N. Long. 75° 10′ 28″ W. Height above the sea 50 feet. Prof. J. A. KIRKPATRICK, Observer.									CHAMBERSBURG, Franklin Co. Lat. 39° 58′ N. Long. 77° 45′ W. Height 618 ft. WM. HEYSER, Jr., Obs.							INDIANA, Indiana Co. 40° 40′ N. 79° 10′ W. Height, 1321 ft. W. B. HILDEBRAND, Obs.				FREEPORT, Armstrong Co. 40° 44′ N. 79° 42′ W. Height 1000 feet. J. H. BAIRD, Obs.		
1860.	Barometer.		Thermometer.			Force of vapor.	Relative humidity.	Rain.	Prevail'g winds.	Barom	Thermom.		Force of vapor.	Relative humidity.	Rain.	Prevail'g winds.	Thermom.		Rain.	Prevail'g winds.	Thermometer.		Prevailing winds.
July.	Mean.	Mean daily range.	Mean.	Daily oscillation.	Mean daily range.	2 P.M.	2 P. M.			Mean.	Mean.	Mean daily range.	2 P. M.	2 P. M.			Mean.	Mean daily range.			Mean.	Mean daily range.	
	Inch.	Inch.	°	°	°	Inch.	Per ct	Inches.	Direc.	Inch.	°	°	Inch.	Per ct.	Inch.	Direc.	°	°	Inch.	Direc.	°	°	Direc.
1	29·817	·134	74·3	17	11·0	·288	29	0·005	N.	29·249	71·0	9·0	·564	80	0·567	S.	73·0	1·7		N W.	67·7	6·7	N W.
○ 2	29·867	·065	77·0	21	2·7	·463	40		N W.	29·284	73·0	8·0	·718	77	0·100	W.	73·0	2·0		N E.	69·3	5·3	?
3	29·808	·074	71 7	4	5·3	·634	78	0 113	(var.)	29·162	78·7	5·7	·832	71		W.	74·3	2·0		N E.	70·3	3·7	W.
4	29 632	·176	79·0	20	7·3	·743	58	0·308	(var.)	28·740	76·7	2·7	·860	79	0·200	W.			R.				W.
5	29·545	·087	78·7	24	4·7	·534	38		(var.)	28·913	78·0	4·7	·746	64		W.					74·0		(var.)
6	29·810	·265	64·2	14	14·5	·378	53		N E.	29·174	64·3	13·7	·403	67		(var.)	74·0			W.	62·0	12·0	E.
7	29·884	·078	69·5	19	5·3	·289	33		E N E.	29·270	67·3	3·0	·403	52		N E.	70·3	3·7		S E.	66·7	5 3	(var.)
8	29·732	·152	70 8	20	5·0	·481	47	0·018	S S W.	29·068	74·0	3·3	·527	57		(var.)	69·0	2·0		S E.	70·3	3·7	(var.)
9	29·675	·106	80·0	21	9·2	·595	44		S W.	29·143	77·3	6·7	·582	50		(var.)	74·0	5·0		E.	74·0	3·7	W
10	29·818	·145	84·3	22½	4·3	·560	37		S W.	29·193	81·0	5·3	·555	41		S.	77.7	1·0		N E.	78·0	4·0	W.
☾ 11	29·902	·085	76·3	14	8·0	·417	38		N N W.	29·304	76·7	6·0	·598	58		(var.)	70·3	7·3		N E.	65·3	12·3	(var.)
12	29 917	·014	71·3	20	5·0	·321	32		N W.	29·342	68·0	8·7	·371	49	0·215	(var)	63·3	7·0		N E.	61·3	4·3	N.
13	29 933	·035	72·3	22	1·0	·355	36		(var.)	29·339	67·7	3·0	·358	46		N E.	67·7	4·3		N.	63·7	2·3	?
14	29·936	·019	75·3	23	4·0	·404	36		N E.	29·349	70·7	3·0	·356	38		(var.)	71·0	6·0		N.	71·3	7·7	W.
15	29·908	·038	78·8	26	3·5	·384	30		S W.	29·290	77·0	9·7	·512	45		W.	74 7	4·0		S W.	74·0	3·3	W.
16	29·752	·156	84·0	25½	5·2	·506	34		S W.	29·186	80·7	3·7	·543	42		W.	77·0	2·3		S W.	79·0	5·0	S W.
17	29 799	·088	81·0	18	3 7	·431	32		N W.	29·225	79·3	4·7	·531	44		W.	75·0	3·3		W.	71·7	7·3	N.
● 18	29·929	·129	79·0	25	2·7	·458	36		S E.	29·289	79·0	4·3	644	52		(var.)	76·0	1·7		S W.	74·7	6·3	S.
19	29·812	·116	82·8	19	3·8	·672	49	0·006	S W.	29·237	80 0	5·0	·819	68	0·175	W.	78·0	2·0	0.280	S W.	74·0	2·0	(var.)
20	29·755	·057	87·7	22½	4·8	·675	41		N W.	29·187	83·3	4·0	·609	46		W.	76·0	2·0		S W.	79·7	5·0	?
21	29·579	·176	81·7	16	6·0	·657	51	0·084	S W.	29·002	81·3	3·3	·733	61	0·180	(var)	71·0	5·0	0·380	W.	72·0	7·7	W.
22	29·734	·155	76 2	15	5·5	·368	33		(var.)	29·134	73·0	11·3	·497	46		W.	68·3	2·7		N W.			?
23	29·588	·146	77·8	17	1·7	·571	48	0·119	W.	29·010	75·3	5·0	·588	55		W.	69.7	4·0	0.170	N W.	66·0		N W.
24	29 840	·252	71·7	21	6·2	·288	29		(var.)	29 254	70·0	5·0	·382	44		W.	67·3	2·3		W.	64·3	2·3	N W.
☽ 25	29·926	·085	75·5	24	3·8	·514	46		S W.	29·332	73·0	3·3	·574	58		W.	72·3	5·0		W.	69·0	4·7	N W.
26	29·851	·076	76 7	26	1·2	·756	67	0·014	(var)	29·228	76·3	3·0	·447	40		W.	72·3	2·0		W.	76·0	7·0	W.
27	29·806	·098	76·2	20	1·8	564	47	0·184	(var.)	29·233	76·3	3·7	·585	55	0 890	(var.)	73·3	5·7	0·160	N E.	68·3	7·7	N W.
28	29·936	·137	72·2	21½	4·0	·403	39		S E.	29 353	74·7	3·7	·650	59		(var.)	73·3	0·7		N E.	74·0	5·7	(var.)
29	29·782	·154	74·7	15½	3·5	·687	69		S E.	29·117	76 3	3·0	·829	78	0·247	E.	73·0	1·0	1·120	N W.	75·3	5·3	S W.
30	29·617	·168	81·8	16	7·2	·630	51		S E.	29·077	77·7	2·7	·690	63		E.	71·3	3·0		N W.	69·7	5·7	N W.
31	29· 629	·014	81·7	24	2·8	616	44		S W.	29·106	75·0	2·7	·637	62		E.	68 3	3·7		N.	67·7	2·0	(var.)
Means	29·791	·112	76·9	20	5·0	·505	43	0·851	s70°w	29·186	75·2	5·2	·588	56	2·564	s79°w	72·2	3·3	2·110	n31°w	70·5	5·5	n 66½° w.

Abstract of Meteorological Observations for July, 1860; *made in Adams, Dauphin, Northumberland, Centre, and Somerset Counties, Pennsylvania, for the Committee on Meteorology of the Franklin Institute.*

	GETTYSBURG, Adams Co. Lat. 39° 49′ N. Long. 77° 18′ W. Ht. 624 ft. Prof. M. JACOBS, Obs.					HARRISBURG, Dauphin Co. 40°16′, N. 76°50′, W. Ht., 300 ft. JOHN HEISELY, M.D., Obs.					SHAMOKIN, Northumberland Co. 40° 45′ N. 76° 30′ W. Height, 700 ft. P. FRIEL, Obs				FLEMING, Centre Co. 40° 55′ N. 77° 53′ W. Ht., 780 feet. S. BRUGGER, Obs.				SOMERSET, Somerset Co. Lat. 40° N. Long. 79° 3′ W. Height 2195 feet. GEO. MOWRY, Observer.						
1860.	Barom	Thermom.				Barom	Thermom.				Thermom.				Thermom.				Barom	Thermom.					
July.	Mean.	Mean.	Mean daily range.	Rain.	Pre-vail'g winds.	Mean.	Mean.	Mean daily range.	Rain.	Pre-vail'g winds.	Mean.	Mean daily range.	Rain.	Pre-vail'g winds.	Mean.	Mean daily range.	Rain.	Pre-vail'g winds.	Mean.	Mean.	Mean daily range.	Force of vapor. 2 P.M.	Relative humidity. 2 P.M.	Rain.	Pre-vail'g winds.
	Inch.	°	°	Inch.	Direc.	Inch.	°	°	Inch.	Direc.	°	°	Inch.	Direc	°	°	Inch.	Direc.	Inch.	°	°	Inch.	Per ct.	Inch.	Direc.
1	29·453	68·7	12·3	0·325	N E.	29·719	73·0	12·7	0·121	(var.)	58·7	17·7	0·700	E.	67·0	4·3	0·905	(var.)	27 710	72·3	0·3	·623	59	0·962	(var.)
○ 2	29·473	74·7	9·3		S W.	29·746	78·0	7·7		(var.)	70·0	11·7		W.	73·0	6·0		E.	27·736	74·0	2·3	·768	63	0·199	W.
3	29·374	80·0	5·3		W.	29 655	81·3	3·3		N.	73·3	4·0		(var.)	77·7	4·7		W.	27 699	76·0	2·0	·880	61	0·080	W.
4	29·222	80·3	2·3	0·015	S W.				0·635	S W.	76·3	3·0	0·568	W.	76·0	2·3	0 730	N W.	27·570	73·3	5·3	·750	72	0·424	W.
5	29·134	79·5	2 5	0·045	S W.	29·402	80·3			(var.)	72·0	4·3		W.	74·0	2·0		N W.	27·496	70·7	2·7	·625	65		W.
6	29·402	65·7	13·8		N E.	29·683	68·0	12·3		N E.	60·0	12·0		W.	62·7	11·3		E.	27·621	62·3	8·3	·424	64		E.
7	29·476	67·0	4·0	0·040	S E.	29·744	70·7	4·7		(var.)	63·3	8·7		W.	69·0	6·3		S E.	27·700	61·3	2·3	·335	47		E S E.
8	29·261	69·7	4·0		S S W.						64·7	1·3	0·131	E.	67·7	5·3	0·070	S W.	27·494	68·3	7·0	·543	56	0·150	S.
9	29·270	77·7	8·0		WSW	29·514	80·3			S W.	73·3	8·7		W.	72·7	5·0		N W.	27·582	71·0	2·7	·609	56		W.
10	29·381	82·7	5·0		S W.	29·652	86·0	5·7		S W.	76·0	6·7		W.	78·3	5·7		(var.)	27·689	78·3	7·3	·695	44		W.
☾ 11	29·549	76·0	7·0		(var.)	29·785	78·7	7·3		N.	69·7	8·3		W.	71·0	7·3		N W.	27·800	67·3	12·3	·477	54		N W.
12	29·597	64·0	11·7		N.	29·843	71·7	7·0		(var.)	58·3	11·3		W.	62·7	8·3		W.	27·825	57·7	9·7	·348	51		WNW
13	29·533	66·7	6·7		N.	29·797	73·3	2·3		(var.)	62·7	4·3		W.	66 0	4·0		N W.	27·817	59·7	2·0	·416	52		N E.
14	29·551	70·7	4·0		N W.	29·819	76·7	3·3		S W.	72·7	8·0		W.	68·0	2·0		(var.)	27·808	65·0	5·3	·415	40		E S E.
15	29·501	76·7	6·0		W.	29·761	78·3	3 7		W.	70·0	3·3		(var.)	71·3	4·0		(var.)	27·788	69·0	4·0	·648	54		W.
16	29·373	81·7	5·0		(var)	29·627	84·7	6·3		W.	74·7	4·7		W.	79·0	7·7		(var.)	27·724	71·7	4·0	·704	55	0·578	W.
17	29·380	79·3	5·7		N W.	29·680	82·0	5·7		N.	72·7	11·3		E.	73·0	8·0		(var.)	27·720	70·0	1·7	·662	57		WNW
● 18	29·465	77·3	2·7		S W.	29·763	81·3	4·0		S.	71·0	9·0		E.	74·7	7·0		(var.)	27·738	75·0	6·3	·767	51		S.
19	29·422	80·0	2·7	0·058	S S W.	29·672	85·0	3·7		S W.	81·0	10·0		E.	78·7	4·0	0·050	W.	27·708	72·0	9·7	·698	79	0·503	S W.
20	29·379	84·3	4·3		(var.)	29·639	87·7	2·7		W.	82·0	1·0		(var.)	78·0	2 0		N W.	27 722	77·3	6·0	·849	68		W S W
21	29·185	82·3	4·0	0·060	WSW	29·436	86·0	3·0		W.	74·7	7·3	0·033	N W.	72·7	6·7	0·100	W.	27 561	73·0	4·3	·801	71	0·412	W.
22	29·342	74·0	8·3	0·550	S W.	29·619	77·0	9·0		(var.)	67·3	7·3	0·242	W.	71·3	6·0		W.	27·615	66·7	6·3	·570	63		N W.
23	29·183	74·0	2·0		N W.	29·452	78·7	1·7	0·265	W.	74·0	6·7		W.	70·3	1·0		N W.	27·522	67·7	3·0	·664	69	0·569	W.
24	29·460	68·7	5·3		(var.)	29·729	72·3	6·3		(var.)	62·7	11.3		(var.)	65·0	5·3		W.	27·722	58·7	9·0	·403	53		W.
☽ 25	29·551	73·7	5·0		S W.	29·818	76·7	4·3		S W.	63·3	3·7		(var.)	68·7	3·7		(var.)	27·800	65·7	7·0	·584	55		W.
26	29·424	78·0	3·7	0·255	S W.	29·704	80·3	3·7	0·410	S E.	70·0	8 3		W.	74·7	6·0		W.	27·737	71·7	6·0	·603	55	0·426	W.
27	29·425	73·7	4·3		N W.	29·677	78·3	2·0		N W.	72·0	7·3		W.	72·7	4·7		N W.	27·724	69·7	8·0	·499	50		W.
28	29·575	74·7	1·0		S S E.	29·850	75·7	4·0		E.	65·0	9·7		(var.)	73·7	7·0		(var.)	27·772	69·0	6·7	·573	58		S E.
29	29·366	74·7	0·7		S W.	29·624	78·3	5·3	0·397	(var.)	70 7	13·7	0·176	E.	72·3	6·0	1·010	S W.	27·606	72·7	5·0	724	79	0·516	(var.)
30	29·249	77·0	2·3		(var.)	29·525	79·7	3·3		(var.)	73·3	5·3	0·125	W.	72·0	7.7		W.	27·594	69·7	3·7	·632	67		N W.
31	29·290	74·7	3·0		N W.	29·545	79·0	2·0		N.	71·7	7·0		(var.)	73·0	3·7		W.	27·606	68·0	2·3	·556	59	0·342	(var.)
Means	29·392	77·0	5·2	1·348	S 84° W	29·672	78·6	5·1	1·828	S 86° W	69·9	7·7	1·975	N 86° W	71·8	5·3	2·865	N 89° W	27·684	69 2	5·2	·608	59	5·161	S 72° W.

JOURNAL

OF

THE FRANKLIN INSTITUTE

OF THE STATE OF PENNSYLVANIA,

FOR THE

PROMOTION OF THE MECHANIC ARTS.

NOVEMBER, 1860.

CIVIL ENGINEERING.

For the Journal of the Franklin Institute.

Notes of Ship-Building in New York and Vicinity.

Judging from present indications, it would seem that the shipping business of New York and its vicinity is to experience a great revival from the dullness and stagnation which has heretofore prevailed. During the past four years, there has been a general depression among ship-builders, whilst ship-owners have been steadily sinking immense sums of money, much less realizing those handsome incomes, which, a few years since, marked the business of navigation; they have not only experienced very light freights, but have been compelled to see their once magnificent and busy vessels lying idle, and rotting at their docks for lack of employment.

But now, the aspect has changed, and it is sincerely hoped that the gratifying signs at present universally manifest, will not be spasmodic and soon pass away, but that prosperity of trade in general, and a succession of good crops, will follow and create a constant demand not only for the fine vessels afloat, but for new and improved ones, which New York and vicinity have almost unlimited means of supplying.

The cause of the present activity in our ship-building is easily explained. It is the great abundance of crops throughout the whole extent of our Union, for which the comparative dearth in Europe necessarily creates an extensive demand; this is, undoubtedly, the principal cause, but there are others, equally important, to which it is attributable, viz: the unexampled success attending the many efforts of our respective ship-builders.

Science and art have extended their aid in no other department of handiwork more particularly than in this. American skill and American ingenuity have produced models in this respect which are everywhere recognised as the best; and it is but recently that special agents were sent to this country by foreign powers to superintend the erection of vessels intended for them; but of this a single word hereafter.

The prominent feature of the work as at present in progress throughout the various ship-yards, is the large number of steamers upon the stocks. But few packet ships are in course of construction: in fact, the smallest vessels are being built with steam power to propel them. This little circumstance only proves how rapidly the revolution from canvass to steam is progressing, and indicates that ere long sailing vessels will be entirely superseded by steamers, particularly for the coasting trade.

Visiting a ship-yard to me is always pleasant, but at the present period far more so than usual; as the busy hum, the merry chorus of the ringing axes and clanking hammers, present indubitable evidence of the great activity with which the work is progressing. Annexed will be found a review of the operations now in progress at our yards, which will give an impression of the state of the business.

The Steamer Guadalquiver.

Hull built by Jacob Westervelt & Co., New York. Machinery to be constructed by a foundry in Cuba. Owners, parties in Havana. Intended service, coasting around the island of Cuba.

Hull.—Length on deck, 160 feet 6 ins. Breadth of beam (molded), 23 feet 8 ins. Depth of hold, 10 ft. Depth of hold to spar deck, 10 ft. 3 ins. Frames—molded, 11 ins.—sided, 5½ ins.—apart from centres, 20 ins., and square fastened with copper, &c. Draft of water, 4 feet; when fully equipped for service, with her engines and coal, will draw 6 ft. of water Masts, two—Rig, schooner. Tonnage, 375 tons.

Machinery.—To be put in immediately after her arrival in Cuba. Of its dimensions or description, I have no knowledge.

Remarks.—This vessel is of a beautiful model, with very sharp and easy lines. Her frame is of live oak; the keelsons and ceiling of yellow pine; the planking is of yellow pine and white oak. The decks are of yellow pine, and the combings of mahogany.

The Steamer John P. King.

Hull built by Jacob Westervelt & Co., New York. Machinery in process of construction by the Allaire Works, New York. Owners, Spofford, Tileston & Co. Intended service, New York to Charleston, S. C.

Hull.—Length on deck, 236 ft. Breadth of beam (molded), 36 ft. 6 ins. Depth of hold, 13 ft. 8 ins. Depth of hold to spar deck, 21 feet. Frames—molded, 15 ins.—sided, 14 ins.—apart from centres, 30 ins., and very securely fastened with copper, &c. Tonnage, 1572 tons.

Engines.—Vertical beam. Diameter of cylinder, 71 ins. Length of stroke of piston, 12 feet.

Boilers.—Two—Return flue. Length, 26 feet. Breadth, 12 ft. 3 ins. Height, 12 ft. 3 ins.

Paddle Wheels.—Diameter over boards, 28 ft. Material of iron. Number, 24.

Remarks.—This steamer is very strongly built, her frame being white oak throughout. Her model is handsome and such as to insure great speed. This vessel was named in honor of the President of the Georgia Railroad. Capt. Richard Adams, formerly of the *James Adger*, will command her.

The Steamer John P. Jackson.

Hull built by Devine Burtis, Red Hook, L. I. Machinery in process of construction by Wm. Birkbeck, Jersey City. Owners, New Jersey Ferry Company. Intended service, New York to Jersey City.

Hull.—Length on deck, 210 ft. Breadth of beam (molded), 33 ft. 6 ins. Depth of hold, 12 ft. 8 ins. Draft of water, 5 ft. 6 ins. Floors—molded, 14 ins.—sided, 6 ins.—apart from centres, 16 ins. Her frame is of white oak, chestnut, &c., and very securely fastened with copper and treenails. Tonnage, 860 tons.

Engines.—Vertical beam. Diameter of cylinder, 48 ins. Length of stroke of piston, 11 feet.

Boiler.—One—Drop flue. Length, 30 ft. Breadth, 10 feet. Height, 10 feet. Has water bottom. Location in hold. No blowers.

Paddle Wheels.—Diameter over boards, 21 ft. Material of wood. Number, 18.

Remarks.—This ferry boat is probably the largest of its kind in the world: it certainly will be one of the most capacious and splendid vessels of its class on our rivers, when finished. Her wood work consists of the best quality of oak, locust, and mahogany. She has one independent steam, fire, and bilge pump, and ordinary bilge injections. Contrary to general usage with such boats, her bottom was entirely coppered at the period of launching. It is customary not to copper them until they have been in service about six months. Her aggregate cost will be $60.000. She will take her appropriate position on the Jersey City Line about the first of November.

The Steamer Fire Dart.

Hull built by Thomas Collyer, New York. Machinery in process of construction by the Neptune Iron Works, New York. Owners, Augustine Heard, Jr., & Co., Boston. Commander, Henry W. Johnson. Intended service, coast of China.

Hull.—Length on deck, 200 ft. Breadth of beam (molded), 30 ft. Depth of hold, 11 ft. Do. to spar deck, 11 ft. 3 ins. Draft of water at load line, 5 ft. 6 ins. Floors—molded, 14 ins.—sided, 5 ins.—apart from centres, 26 ins. Her frame is of white oak, &c., and fastened in the most thorough manner. Tonnage, 650 tons. Masts, two—Rig, Schooner.

Engines.—Vertical beam. Diameter of cylinder, 46 ins. Length of stroke of piston, 12 feet.

Boilers.—Two—Return flued. Length, 27 feet. Breadth, 9 feet 10 inches. Height, 8 ft. 9 ins.

Paddle Wheels.—Diameter over boards, 28 ft. Length of blades, 8 ft. Depth, 2 ft. Number, 24.

Remarks.—This steamer has been constructed of the best materials and put together in a masterly manner. Her model appears to be without fault. She is furnished with guards similar to a steam-ship, and will be enclosed to the promenade deck. Her value when finished will be about $85,000. Mr. Collyer is erecting other vessels (of which mention will be made below) for parties in Boston and China. This builder seems to have achieved a celebrity in the East somewhat akin to other builders with us. It has not been long since papers published in England contained an account of the performances of a new steamer sent from the Clyde, in contrast with the steamer *Yang-tse*, built by Mr. Collyer, and which had been running in Chinese waters a period of three years; they made the reluctant admission that though the former cost nearly three times as much on the Clyde as the latter did in the United States, she consumed double the amount of coal, and had less capacity for freight and passengers, thereby showing a clear triumph for the American steamer.

The Steamer Primeira.

Hull built by Webb & Bell, Green Point, L. I. Machinery in process of construction by the Novelty Iron Works, New York. Owners, Dr. Raney and others, Rio Janeiro, S. A. Intended service, Bay of Rio Janeiro.

Hull.—Length on deck, 130 ft. Width over guards, 50 ft. Breadth of beam, 28 ft. Depth of hold, 10 feet. Do. to spar deck, 9 ft. 6 ins. Draft of water at load line, 6 ft. Floors—molded, 13 ins.—sided, 9 ins.—apart from centres, 24 ins. Frames very securely fastened. Tonnage, 350 tons.

Engines.—Vertical beam. Diameter of cylinder, 32 ins. Length of stroke of piston, 8 ft. To be of 180 horse-power, calculated to insure a speed of 12 knots per hour.

Boiler.—Drop flue. Length, 21 ft. Breadth, 8 ft. 6 ins. Height, 8 ft. 6 ins.

Paddle Wheels.—Diameter over boards, 16 ft. Length of wheel blades, 6 ft. 8 ins. Depth, 2 ft. Number, 14.

Remarks.—This vessel is most appropriately called the *Primeira* (first), and is one of three which are intended for the use of our southern imperial neighbor, designed for service as above stated. Dr. Raney, a gentleman of great energy and enterprise, after a year of most incessant labor, and encountering the combined opposition of the old Thames boat ferry company and the whole English influence, which has monopolized the steam-ship business in Brazil ever since the introduction of steam power, last winter succeeded in establishing a company for running steamers on the American plan, and obtaining a charter from the government, conferring the right of navigating the Bay of Rio Janeiro for a period of thirty years. As no other steamer has ever been built for that country by American ship-builders, it is reasonable to hope that this will give such a good account of herself as to secure more business of the same kind for our yards.

This vessel is constructed with extraordinary strength, her materials being principally of white oak. The ceiling and planking are of 2½ inch white oak, with double frames of the same, continuing from stem to stern, and strongly copper fastened. The manner of her whole construction is highly creditable to the skill of Messrs. Webb & Bell, and gives great satisfaction to her owners. The keel of the other two will be laid immediately. Their aggregate cost will be $180,000.

The Clipper Bark, D. Golden Murray.

Hull built by E. Lupton, Green Point, L. I. Owner, D. Golden Murray, City of New York. Commander, Capt. Richard Lee, formerly of the bark *Lucky Star*. Superintendent of construction, J. C. Conner. Intended service, New York to Galveston, Texas.

Hull.—Length of keel, 112 feet. Do. of main deck, 122 feet. Do. over all, 133 ft. Breadth of beam at midship section, 30 feet. Depth of hold, 12 feet 6 ins. Frames of white oak, &c., &c., and thoroughly fastened. Tonnage, 510 tons.

Remarks.—The model of this bark bespeaks speed and excellent carrying abilities. She is capable of bearing 835 tons dead weight, and then will draw but ten feet of water. She has been fitted with all the modern improvements, having double topsail yards and patent reefs in her courses. There are seven vessels now belonging to this line of packets, and it is expected that this, the last addition, will fully sustain their excellent reputation.

THE ABOVE SIX VESSELS HAVE BEEN LAUNCHED WITHIN A VERY BRIEF PERIOD, AND ARE NOW UNDERGOING THE PROCESS OF COMPLETION WITH ALL POSSIBLE DESPATCH.

The following are still on the stocks, or about being commenced:—

At Thomas Collyer's, New York.

A day boat to run between New York and Albany has just been commenced. She is to run with great economy of fuel, and to be of good speed. The subjoined are some of her dimensions:—

Hull.—Length on deck, 250 ft. Breadth of beam (molded), 30 ft. Depth of hold to spar deck, 10 ft. Frames—molded, 15 ins.—sided, 4 ins.—apart from centres, 30 ins. Draft of water, 5 ft. Tonnage, 700 tons.

Engines.—Vertical beam. Diameter of cylinder, 60 ins. Length of stroke of piston, 10 feet.

Boilers.—Two—Return flued. Length, 29 ft. Breadth, 9 ft. Height, 9 ft. 5 ins. Number of furnaces, two in each.

Paddle Wheels.—Diameter over boards, 30 feet. Length of blades, 9 feet. Number of do., 24.

The machinery to be constructed, I understand, by the Neptune Iron Works.

Also, a steamer for Messrs. John W. Forbes & Co., of Boston, Mass., under the superintendence of George N. Sands, is building here. To be named the *Hankow.**

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* Since launched.

HULL.—Length on deck, 212 feet. Breadth of beam (molded), 30 ft. 6 ins. Depth of hold, 11 ft. 6 ins. Draft of water at load line, 7 ft. Floors, molded, 14 ins.; sided, 7 ins.; apart from centres, 27½ ins. Tonnage, 750 tons. Two masts, schooner rigged. Machinery to be constructed by the Morgan Iron Works.

ENGINES.—Vertical beam. Diameter of cylinder, 48 ins. Length of stroke of piston, 12 feet.

BOILERS.—Two—Return tubular. Length, 20 feet. Breadth, 11 feet. Height, 9 ft. Two furnaces in each boiler.

PADDLE WHEELS.—Diameter over boards, 29 ft. Length of wheel blades, 7 ft. 6 ins. Depth, 2 ft. Number, 26.

This vessel will be made very strong, being iron strapped throughout and well timbered. Materials used, white oak, chestnut, &c. It will cost, when finished, $90,000.

This is the third vessel erected for the China trade for Messrs. Forbes & Co., and three others have been constructed for the Chinese waters; one of which was sold to the French government for a war steamer, and another purchased by the Chinese government for war service, to protect their junks from the depredations of the river pirates who infest their waters. The others are actively employed on the rivers.

Another steamer of smaller dimensions than the above is also in process of construction, for parties in New York, who design placing her in the coasting and river trade in the Chinese Empire.

Her length will be 160 feet. Breadth of beam (molded), 26 ft. Depth of hold, 10 feet. Not yet named. Machinery by the Morgan Iron Works.

In many respects, the details of her construction will be similar to the *Hankow*.

At Henry Steers', Williamsburgh, L. I.

A beautiful side-wheel steamer is being constructed at this place, under the superintendence of Edward N. Dickerson. She is intended to run in conjunction with the Florida Railroad, along the Gulf Coast, between Cedar Keys and New Orleans.

Her dimensions will be as follows:—

Length on deck, 285 feet. Breadth of beam (molded), 37 ft. 6 ins. Depth of hold, 13 feet. Tonnage, 1350 tons.

Another steamer of similar construction will soon be commenced by Mr. Steers.

At Sneden & Rowland's, Green Point, L. I.

A large side-wheel steamer, to run between New York and New Haven, is in process of erection here. Her dimensions will be as follows:—

HULL.—Length on deck, 280 ft. Breadth of beam (molded), 35 ft. Depth of hold, 11 ft. Draft of water, 6 ft. Frames, of white oak, chestnut, and cedar, copper fastened, and diagonally and double laid with iron straps, 3½ by 9-16ths of an inch. Tonnage, 1200 tons.

Engines.—Vertical beam. Diameter of cylinder, 65 inches. Length of stroke of piston, 12 feet.

Boilers.—Two—Return flued.

Paddle Wheels.—Diameter over boards, 28 feet.

The machinery is to be constructed by the Neptune Iron Works, New York.

The erection of two more steam vessels has also been commenced. They are intended for the Norwich and New York Steam Navigation Co., to run in conjunction with the Norwich and Worcester Railroad. Their principal dimensions will be:—

Length on deck, 300 feet. Breadth of beam (molded). 37 ft. 6 ins. Depth of hold, 13 feet. The contract for constructing the machinery has just been completed with the Novelty Iron Works. They will have beam engines, with a cylinder 75 inches in diameter, and stroke of piston of 12 feet. Their tonnage will be 1350 tons each.

The keel of an iron propeller has also been laid. She is building for Pezant Bros. & Co., to run between Mexico and Cuba in the cattle trade. Her dimensions will be:—

Length on deck, 135 feet. Breadth of beam, 22 feet. Depth of hold, 5 feet. She will be supplied with Ericsson's hot-air engine. Tonnage, 300 tons.

This firm will immediately begin an iron steamer for the New Orleans and Mobile mail route. The machinery, I understand, is to be constructed by the Morgan Iron Works. I append her principal dimensions:—

Hull.—Length on deck, 250 feet. Breadth of beam, 34 feet. Depth of hold, 10 feet. Floors—┐, molded, 3½ ins.—sided, ⅜ths of an inch. Frames—angle iron, 3½×3½×⅜—apart from centres, 18 ins. Five single plates, fore and aft. Keelsons, having four angle bars on each, ⌶. Keel, U, ⅝ thick. Tonnage, 650 tons.

Engines.—Vertical beam. Diameter of cylinder, 50 ins. Length of stroke of piston, 10 feet.

Boiler.—Return flued.

Paddle Wheels.—Diameter over boards, 30 feet, with a face of 10 feet.

At Lawrence & Foulk's, Williamsburgh, L. I.

They have upon the stocks and nearly completed a steamer for the Spanish Government, intended for towing purposes in the harbor of Havana. Her dimensions are:—

Length on deck, 100 ft. Breadth of beam, 24 ft. Depth of hold, 9 ft. 6 ins. Tonnage, 275 tons.

Machinery—By the Fulton Iron Works.

Engine.—Vertical beam. Diameter of cylinder 30 ins. Length of stroke of piston, 6 feet.

The cost of this boat, when finished, will be $30,000.

At Wm. H. Webb's, New York,

Is now building a magnificent side-wheel steamer for Saml. L. Mitchell's New York and Savannah Line. Her dimensions will be:—

Length on deck, 250 ft. Breadth of beam (molded), 38 ft. Depth of hold, 22 ft. 6 ins. Tonnage, 1750 tons.

These dimensions will make her considerably larger than any vessel on the line, and will increase the number of running ones to four side-wheel steamers and one propeller. Machinery by the Morgan Iron Works.

Mr. Webb is also building a large packet ship for the Black Ball Line. Owners, Charles H. Marshall & Co., City of New York. She will be constructed of white and live oak and locust, and possess two decks. Her dimensions are:—

Length on deck, 278 ft. Breadth of beam, 39 ft. Depth of hold, 23 ft. Tonnage, 2000 tons. Will be completed about the middle of November.

A brig of 270 tons is also building here. Her destination will be the Brazos River.

At S. Allison's, Jersey City.

A steamboat for Roman & Tremper, Kingston, N. Y., is building here. The route of her intended service will be between the City of New York and Kingston, on the North River. Her dimensions are:—

Length on deck, 242 feet. Breadth of beam (molded), 34 ft. 3 ins. Depth of hold, 9 feet. Engine of 56-inch cylinder, and 12 feet stroke of piston.

She will be finished in the course of two months, and will then take the place of the *North America*, which is getting very old.

At Webb & Bell's, Green Point, L. I.,

Is building a fine steamer for the Stonington Line. She will be 272 feet in length, 32 feet beam, and 10 feet depth of hold. The Novelty Iron Works will construct the machinery.

They have also on the stocks a brig of 250 tons, for I. & N. Smith & Co., City of New York,.to run between New York and the West Indies. Her dimensions are:—

Length on deck, 117 ft. Breadth of beam, 27 ft. Depth of hold, 8 ft. 6 ins.

Her cost will be $120,000.

At Roosevelt, Joyce & Co.'s, New York.

They have in course of erection at their yard four ferry boats, each of 500 tons burthen. Two are for the Union Ferry Co., and the others for the East River Ferry Co., City of New York. The latter intending to ply between Hunter's Point and New York, in connexion with the Long Island Railroad Company. The former will run between the City of New York and Brooklyn. The machinery of the lot will be supplied by the Allaire Iron Works. The cylinders of the engines will be 34 inches in diameter, with a stroke of piston of 9 ft.

At Novelty Iron Works, New York.

At this place a beautiful iron screw steamer is now building. Owners, H. Cromwell & Co. Intended service, New York to Wilmington, N. C. Her principal dimensions will be:—

Length on deck, 180 ft. Breadth of beam, 25 ft. Depth of hold, 15 ft. Her hull will be of iron, whilst the upper portion will consist of wood, constituting her one of the staunchest vessels in our waters. Her engine will be of 42 inches diameter of cylinder, with a stroke of piston of 3 ft. 6 ins. Her propeller will be 12 feet in diameter. Tonnage, 650 tons.

These works have also contracted to erect an iron steamer, 100 feet in length, for parties in Carthagena, South America.

Thus, it will be seen by these particulars that no surer or more reliable index of the skill of our mechanics and the prosperity and welfare of our commercial relations can be found, than in the activity of the ship-building trade of the City of New York and its vicinity.

E. B.

*The Incrustation of Boilers.**

Mr. James R. Napier, ship-builder and engineer, of Glasgow, submitted to the Philosophical Society of that city, on the 18th ult., a very interesting paper on the incrustation of boilers using sea-water, to which we think it desirable to draw particular attention. It appears that on a former occasion Mr. James Napier, chemist, read a paper on the same subject to the Society, in which he made certain suggestions. Feeling much interested in these suggestions, Mr. James R. Napier put them to trial on board the Islesman, on a voyage to the north of Scotland in 1858, in order, if possible, to see the effect. On this occasion, we are told, half a pound of dissolved soda ash was forced into the boiler along with the feed-water at 9h. 30m.; at 11h. 30m. another half pound was forced in; at 3h. 30m. one pound was forced in; and at other times, more was put in. The only effect observed by these operations was making the water in the gauge glass of a milky appearance within a few minutes after the soda was introduced; it continued so for probably an hour after each injection, a small pipe near the surface of the water allowing a continuous discharge from the boiler.

The experiments showed that if the system proved economical, a simple plan could easily be arranged for carrying it out. But as Mr. Napier, in his paper, states "that this sort of crust (sulphate of lime) cannot be avoided by care or mechanical means, except by keeping the salt in the water under its crystallizing quantity, which would necessitate such an amount of blowing off and supply as would render it expensive," the expense of both methods was calculated—the chemical one of neutralizing the sulphate of lime with soda, and the mechanical one of an abundant discharge and supply, so as to keep the sulphate of lime under its crystallizing quantity. It is necessary for this purpose to know the relative proportions of feed-water, and water required to be discharged, in order to prevent scale or crust. Many writers treat this crust, says Mr. J. R. Napier, as if it were common salt, and instruct persons how to make and graduate instruments for ascertaining its quantity, the graduations being effected by observing the depths to which the instrument sinks in water in which certain proportions of common salt has been dissolved. They say, sea-water contains 3 per cent. of salt, and when the boiler contains less than 12 per cent. there will be little or no crust; therefore it is necessary to blow off 3-12ths or 1-4th of the feed-water, in order to prevent the formation of crust. This reasoning, however, as Mr. Napier remarks, is unsatisfactory; as it is evident to any one who has the sense of taste, that the crust is not common salt; and chemical analysis shows that sea-water from the English Channel, although it contains nearly 3 per cent. of common salt, contains only about 0·8 per cent. of the materials forming the crust, and only 0·14 per cent. of the material of which, according to Mr. Napier, chemist, upwards of 90 per cent. of the crust is composed. It is also shown by analysis that a saturated solution of this material (sulphate of lime) in cold distilled water, is as 1 to 380, and as 1 to 388 in boiling water, or 25·7 parts of lime to 10,000 of solution. Mr. Napier, however, found 203 grains of sulphate of lime per gallon in water taken from a boiler off Ailsa Craig. Its density is not stated; but assuming it to contain twice its natural quantity of saline matter, or its density to be 1·0548, sea water being 1·0274,—this gives the ratio 203 to 73,836, or 1 of sulphate of lime to 364 of solution, or 27·47 of sulphate of lime to 10,000 of solution. This proportion, it is inferred, is either a saturated solution, or such as the engineer of the vessel found little or no crust formed in. For want of better data, 28 of sulphate of lime to 10,000 of solution is assumed as the limit of saturation in boilers using sea-water, working at pressures not exceeding 20 lbs. above the atmosphere. This is equivalent to discharging 14-28ths, or one-half of the feed-water. This assumption is confirmed by the practice of the British and North American Mail Company; by Mr. Napier's Ailsa Craig engineer, who was evidently blowing off nearly this amount; and by an experiment of Mr. Thomas Rowan, of Glasgow, made for the purpose of ascertaining when the sulphate of lime and when the common salt deposited. He found, when he

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*From the London Mechanics' Magazine, Feb., 1860.

evaporated	2-10ths	of the water, a trace of sulphate of lime deposited.
"	4-10ths,	ditto, ditto.
"	5-10ths,	the sulphate of lime began to deposit in larger quantities.
"	6-10ths,	ditto, decided quantities.
"	8-10ths,	sulphate of lime deposited in very large quantities; also magnesia and salt began to form.

"Mr. Rowan's experiment," says Mr. J. R. Napier, "although indefinite as to the quantities, shows that the sulphate of lime begins to deposit before even one-half of the water is evaporated. It is probable, therefore, that this quantity, or more, would require to be discharged in order to prevent the formation of crust in boilers."

A saturated solution of common salt in distilled water is given as 27 of salt to 100 of solution; and a saturated solution in sea-water is aid to be 36 of salt to 100 of solution. The former ratio has been hosen for comparison in this case, so that 27-270ths, or only 1-10th, of he feed-water would require to be discharged in order to prevent the ormation of common salt, and 8-10ths to be neutralized by soda to revent the deposit of sulphate of lime, the 1-10th discharged being a aturated solution of sulphate of lime and common salt. It is thus hown, that by the chemical method it is necessary to discharge 1-10th f the feed-water, and neutralize the sulphate of lime in 8-10ths of it ith soda, according to Mr. Napier's method, to prevent crust; and y the mechanical method, it is necessary to discharge 5-10ths. The uantity of soda ash (supposed to contain 50 per cent. soda) is found y the formula $\frac{62}{68}$ of $\frac{14}{10000}$ of $\frac{8}{10}$ of feed-water.

For the purpose of illustrating the expense of both methods of preenting crust, and also the loss by the blowing-off method, the case of vessel has been taken by Mr. J. R. Napier, working at a temperaure of 270°, and evaporating at that temperature 7½ lbs. of water rom 100° per lb. of coal.

		Chemical Method.
ea-water supplied to boiler, temp. 100°,	15·0 lbs.	8·33 lbs.
Vater discharged, 270°,	7·5 "	0·83 "
Vater evaporated,	7·5 "	7·5 "
otal heat evaporating from 100° at 270° $h_{1\cdot 2}$ $= 1092 + 3\text{-}10\,(T_1 - 32, - (T_2 - 32)$ $= 1095\cdot$	8215°·5	8215°·5
Ieat discharged,	1275°	142°
uel consumed in evaporation,	1·0 "	1·0 " coal.
uel consumed in preventing crust,	0·155 lbs. coal,	0·0172 lbs. coal + 0·0085 lbs. soda ash.
Total fuel,	1·155 lbs. coal,	1·017 lbs. coal + 0·0085 lbs. soda ash.

Thus, it is seen that it requires only 172 lbs. coal + 85 lbs. soda ash, containing 50 per cent. soda, to be as efficient in preventing crust as 1550 lbs. of coal alone, which evaporates 7½ lbs. water from 100° at 270°. And these methods are equally expensive when the soda ash is 16·2 times dearer than the coal. This ratio varies with the efficiency of the fuel and the temperature of evaporation.

Although when coals are 10*s.* and soda ash £10, Mr. Napier's method is more expensive than the ordinary one of discharging the saturated water, there are many cases where it is probable the owners of vessels would profit by its adoption. In long voyages, for example, a vessel requiring by the ordinary mode 1155 tons of coal, would by Mr. Napier's method require, as Mr. J. R. Napier remarks, 1017 tons coal, and 8½ tons soda ash, or 1025½ tons weight. There would be a saving in money, therefore, of 138 tons coal, 129 tons of freight, and 8½ tons of soda ash; or if coals are 10*s.* per ton, freight £3, and soda ash £11 per ton, the saving would be £362. That boilers, however, can be worked till the water in them is nearly saturated with common salt, or that the soda ash can be so accurately proportioned as *exactly* to neutralize the sulphate of lime, are problems which are believed to be new, and have not yet been attempted. The considerable saving which may be effected, shows that the method is worthy of a trial.

We quote the following remarks from the conclusion of Mr. J. R. Napier's paper:—

"From the foregoing example," he says, "of a vessel worked at a temperature of 270°, it is also seen that a quantity of fuel, equal to 15½ per cent. of that which produces evaporation, is consumed by the ordinary blowing-off method, in order to prevent crust, and this amount increases with the temperature. Brine chests have been frequently used for the recovery of this notable loss; but apparently from a misapprehension of the quantity of water necessary to be discharged, and a want of knowledge of the amount of surface required to absorb the discharged heat, of a capacity greatly too small for their purpose. If Peclet's formula for calculating this surface is to be trusted, those chests on board the West India mail steamship *La Plata*, and some of the British and North American Company's packets, are 1-15th to 1-20th of the size that would be efficient. When these brine chests, regenerators, or heat economizers, therefore, are made with a *sufficient* amount of surface, so that abundance of water can be supplied to and discharged from the boilers with little loss of heat, then there will be no incrustation of boilers, and a probable saving of from 12 to 13 per cent. of their fuel. Peclet's formula, or Professor Rankine's reduction of it, which gives the probable amount of surface required for a difference of temperature of 140° between the feed and the discharged water, at 1-10th square foot per ℔. of brine discharged per hour, becomes under the same circumstances, and when the quantity of brine discharged is equal to the quantity of water evaporated, 1-10th square foot of surface per ℔. of water *evaporated* per hour. The introduction of Dr. Joule's spiral wires to the system will probably render less surface efficient. This amount of discharge and surface, it is expected, will prevent incrustation, and save nine-tenths of the heat at present lost."

*On the Construction of Artillery and other Vessels to resist great internal pressure.** By J. A. LONGRIDGE, M. Inst. C. E.

It was stated in the outset, that it was not proposed to treat of the very wide range of subjects involved in the construction of the most perfect description of ordnance, but to limit the inquiry to the question, how to make a gun of sufficient strength to enable the artillerist to obtain the full effect of the explosive compound used in it? This question was one which the civil engineer was probably more fitted to deal with than the artillery officer, inasmuch as it required nothing beyond a knowledge of the properties and laws of action of those materials with which his every-day practice made him familiar.

The attention of the author was drawn to the subject early in the year 1855. Following up the reasoning of Prof. Barlow on hydraulic press cylinders, he was led to consider how the internal defect of any homogeneous cylinder could be remedied. Prof. Barlow had shown, that in every such cylinder the increase of strength was not in proportion to the increase of thickness, and that a vessel of infinite thickness could not ultimately resist an internal pressure greater than the tensile forces of the material of which it was composed. The material at the internal circumference might, in fact, be strained to its utmost, when that at the outside was scarcely strained at all. To remedy this, it was necessary that each concentric layer of the gun or cylinder should be in an initial state of stress, such that when the pressure was applied, the sum of the initial and the induced stresses should be a constant quantity throughout the whole thickness of the cylinder. It occurred to the author that this could be accomplished by forming the gun or cylinder of a thin internal shell or case, and coiling round it successive series of wires, each coil being laid on with the tension due to its position.

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* From the Lond. Civ. Eng. and Arch. Journal, Mar., 1860.

The principle of building up a gun in successive layers, with increasing initial tension, was, therefore, that which it was intended to bring forward in this paper. The author claimed no exclusive merit for this idea. Although then unknown to him, it was being followed up by Capt. Blakely, Mr. Mallet, and others, who, however, sought for its practical outcome in rings or hoops, contracted or forced on to the central core. Capt. Blakely had, equally with the author, the idea of making use of wire, although his experiments were entirely confined to hoops. It was in complete ignorance of what others were doing that the author undertook the experiments recorded and described in detail in the present paper. The results were so striking, that he lost no time in bringing them before the War Department. The usual reference was made to the Select Committee at Woolwich, with the usual result. The principle was pronounced to be defective, and not such as to warrant any trials at the public expense. The author, however, continued his experiments, and the results were such as entirely to confirm his confidence in the practical utility of the invention.

Before describing these experiments, the paper referred to the construction of guns as hitherto practised. It was first shown, from the author's experiments, that the strength of powder was about 17 tons per square inch. The system of rifling, involving elongated shots without windage, greatly increased the strain on the gun. This being so, it was not surprising that many attempts to rifle the ordinary guns had proved fruitless. Even independent of this extra strain, experience had shown that for heavy ordnance, cast iron was too weak; and it was believed that this was not owing, as had been stated, to any deterioration in the quality of the material, or to any want of honesty on the part of the contractors, but simply to more work being put upon cast iron than it would bear.

Experiments on the direct tensile force of cast iron must not be depended upon, when the material was cast in a huge mass like that of a 68-℔. gun or a 13-inch mortar. Neither could such experiments be trusted as regarded wrought iron or steel. It was shown that the iron cut from the inner part of the Princeton gun was 50 per cent. weaker, as strained by the explosion, than the bar iron from which it was made. The same decrease of strength, though to a less extent, was found in the case of the great gun forged by the Mersey Iron Company, and presented by them to the country. Moreover, large masses of any metallic substance must always, it was believed, be subject to inequalities of physical structure, which rendered them untrustworthy for heavy ordnance.

These considerations led the author and others to the principle of construction already named. Capt. Blakely and Mr. Mallet sought to apply it by means of hoops, which, under almost any circumstances, gave an increase of strength. If correctly applied, this increase was very considerable, but there were great difficulties in the application. Each hoop was itself subject to the same law as a homogeneous cylinder, and consequently a series of hoops was wanting in that uniformity of strain which was required. It was possible so to adjust the hoops that at the time of explosion the inner surface of each might be equally strained, but the strain on each hoop decreased to the outer surface, so that there was an abrupt change at the junction of any two hoops. Moreover, a very slight error in workmanship would produce a most serious effect. Taking, for instance, an 8-inch gun, constructed of four concentric hoops, the total thickness being 6½ inches, an error of $\frac{1}{500}$-inch in the size of the outer ring would reduce its strength by 43 per cent.

Wire, on the other hand, afforded the greatest possible facility of construction, and the coils might be laid on with the utmost accuracy as regarded tension, and with the same ease and regularity as thread was wound on to a bobbin.

The first series of experiments tried by the author were made with brass cylinders, 1 inch internal diameter and 1-10th inch thick. Into these, various charges of powder were put, and the ends hermetically sealed. The total capacity of these cylinders was 295 grains of powder. One of these cylinders was burst with a charge of 90 grains. Another, exactly similar, but covered with four coils of 1-33 inch steel wire, was uninjured by a charge of 200 grains.

It having been objected, that owing to the brittleness of cast iron it would be impossible to use it in conjunction with wire, cylinders of cast iron of the same size were prepared. Some of them were entirely filled with powder (310 grains), which was then exploded without injury to the cylinder. In this case, the cylinders, which were 1-10th inch thick, were bound round with ten coils of iron wire, No. 21 gauge, or 1-28th inch diameter. The bursting charge, without wire, was 80 grains.

After this, a small gun was made of cast iron, covered with wire. The chase was 3 feet long, and the calibre 3 inches. The cast iron at the breech was ⅝-inch thick, and decreased to ⅜-inch at the muzzle. Iron wire 1-16th inch diameter was used, there being twelve coils at the breech, and four coils at the muzzle. The total weight of the gun with its wrought iron trunnion stock, was 3 cwt. With this gun, and an elongated shot weighing 7½ lbs., and with 11 oz. of government cannon powder, a range of upwards of 1500 yards was attained, the elevation being 7°.

Another application of the principle was stated to be to the cylinders of hydraulic presses, and an instance was given of a cylinder of 6 inches internal diameter, made of cast iron ¾-inch thick, and covered with twelve coils of 1-16th inch iron wire. This cylinder was proved up to 6 tons per square inch, when it gave way by the sides shearing off the bottom plate. The cast iron was not shattered, nor was a single coil of the wire injured.

It was stated that these cylinders could be made at one-fourth the weight and at about one-half the cost of the ordinary hydraulic press cylinders; and that their lightness was of great importance when intended for export to South America and other countries where the means of transport for heavy machinery did not exist.

Translated for the Journal of the Franklin Institute.

Methods employed by the Ancients to Move, Haul, or Raise Blocks of unusual Dimensions. Translated by J. Bennett, C. E.

From Rondelet's "Art of Building."

The immense ruins of the ancient edifices of Egypt bear witness to the taste which the Egyptians had for the grand and durable; the blocks used for their constructions were of enormous size. Herodotus speaks of an edifice which formed a part of the temple of Latona at Buto, whose walls were formed of a single rock 52·8 feet long by as much in height. The ceiling or covering of this edifice was also a single block with 5·28 feet thickness.

In another place he says that Amasis ordered to be transported from the Isle of Eléphantine to the town of Sais, twenty days sail distant, a structure formed of a single block of stone; its exterior length was 27·72 feet by 18·48 wide and 10·56 feet high. The interior measured 24·86 feet in length, by 15·84 in breadth, by 6·6 in height. Two thousand men were employed three years in its transportation.

The mass of this last structure, deducting the empty space within, was 2822 cubic feet, and its weight was 458,744 lbs., on the supposition that the rock was formed of the same granite as the obelisks.

As for the other structure which formed a part of the temple of Latona at Buto, the Greek text of Herodotus seems to describe the four walls as being formed of a single block *hollowed like a trough.* In this case it would have required a block of 147,200 cubic feet, with a weight of 24,260,500 lbs., and supposing it was not transported until after being hollowed, its weight would still have been 9,944,750 lbs.

The transportation of so heavy a mass and of so great volume would appear as an inconceivable difficulty, even by water, on account of the immense size of the vessel or platform required to keep afloat so great a load, which was twenty times that transported by Amasis. The difficulties of unloading and moving upon the ground so great a mass would seem to be insurmountable, as it would not be possible to find machines or rollers strong enough to bear such a weight without crushing. The Count of Carbury, who had charge of the transportation of the rock to St. Petersburg, whose weight was only 3,234,000 lbs., said that it was impossible for him to make use of rollers; even iron ones were insufficient. Balls of wrought and cast iron, which he tried to substitute for them, were flattened and broken, as well as the cushions of the same metal, in which these balls rolled; only those made of a mixture of copper, tin, and calamine could resist the pressure. Still, as we cannot contradict a matter which Herodotus says he saw and regarded with wonder, we must believe that the walls of this structure were hollowed out of a mass of rock found upon the spot. *This conjecture is all the more probable, as Herodotus does not mention where this enormous block came from, nor the mode of its transportation.*

As for the stone which formed the upper part of the structure, it is evident that it must have been taken from another block, and that it must have been moved and raised above the walls. It was 52·8 feet long by as many broad, with a depth of 5·28 feet, making, all trimmed, a mass of 14,720 cubic feet, and a weight of 1,984,950 lbs., supposing the stone to be of a mean hardness with that used for most of the temples and for the steps of the pyramids.

A block of such dimensions must have been moved in the same position it was to have when laid. The operation required a plane and solid surface of great extent; and as wood was scarce in Egypt, we may presume, according to what Herodotus said in relation to the great pyramid of Cheops, that in these extraordinary circumstances the custom of the Egyptians was to construct large causeways and inclined planes of cut stone, upon which they hauled the enormous stones which they prided themselves on using for the construction of their edifices. These means, which would be expensive with us, were but a small matter with them, by reason of the great number of men employed upon their works, and the small wages of the laborers, and the insignificant cost of the materials.

When they had to move round and unwrought masses of granite, such as are found in the quarries of Egypt, they were turned over or rolled by the force of men. In many places far distant from the quarries, are found masses of granite whose transportation appears to have been interrupted by some unforeseen causes.

As for the blocks which do not come in this kind of transportation, and whose surfaces were plane, as that which served for the covering of the temple at Buto and the monolithe structure of Amasis, we believe that they made use of rollers and capstans, the most simple and ancient machines, the most powerful and speedy in their effects. To give our ideas upon this, we report the result of an experiment made upon this subject with a cut stone weighing 1165 lbs.

To drag this stone upon a horizontal surface of the same material and coarsely cut required 818 lbs.

The same drawn upon pieces of wood exacted a force of 703 lbs.

The same placed upon a wood platform and drawn upon wood required a force of 654 lbs. But soaping the two surfaces which slid upon each other, there was only needed 196 lbs.

This stone, put upon rollers 3·2 inches diameter and set in motion upon a surface of the same material, required only a force of 36·68 lbs.; the same rolling upon pieces of wood yielded to an effort of 30 lbs., and when the rollers were put between two pieces of wood 23$\frac{3}{4}$ lbs. sufficed.

It follows from this experiment that to draw a rough stone upon a firm and smooth bottom, there is needed a little over $\frac{2}{3}$ of its weight; the $\frac{3}{5}$, if the surface is of wood; $\frac{5}{9}$, if the movement is made of wood upon wood; and if the two sliding surfaces of wood are soaped, but $\frac{1}{6}$. But if we use rollers placed immediately between the stone and ground there will be required a little over $\frac{1}{32}$ of the weight, and $\frac{1}{40}$ if they roll upon wood; and finally, if they roll between two smooth wooden surfaces there will be needed but about the $\frac{1}{50}$ of the weight.

Still it is proper to remark, that as woods compress under great loads, the rollers made of this material are subject to a change of form, to be crushed, and to sinking in the pieces between which they are placed; this produces a friction, whose effect increases with the load. To raise the obelisk at the square of St. Peter's in Rome, which, with all its fixtures, weighed 829,250 lbs., there were required forty capstans, and to draw it upon a horizontal plane with rollers placed between two wooden surfaces it only needed four; whence it follows in this case that the force was but the $\frac{1}{10}$ part of the weight, while the experiment above cited gives a little over the $\frac{1}{50}$ part. But Fontana, who superintended this operation, observed that most of the rollers, which were 70 in number, were crushed, and that the others sank into the pieces of wood between which they were placed.

To have the full benefit of the rollers they should be as incompressible as the surfaces between which they move. Granite rollers between surfaces of the same material to prevent breaking should be very short, and their number great, to have as little of the load as possible on each. The length should not be over one-and-a-half diameters. When the stone has considerable width they must be set in many rows. This method, if practicable, would have been preferable to the balls, which the Count of Carbury used for the transportation of the rock which served for the base of the equestrian statue of Peter the Great; they required the $\frac{1}{22}$ part of the weight.

From the results of these experiments and the observations to which they give rise, we may calculate the force required to transport the stone which formed the monolithe structure at Saïs, and the covering of the temple at Buto.

Experience with works has taught us that a man of medium strength and used to work like those employed by the ancients can carry a load equal to his weight and haul one-and-a-half times as much, so that for the stone cover of the temple at Buto, whose weight we have estimated at 1,984,950 lbs., there would be required 10,000 men to draw it upon a smooth and solid ground; 9000 to draw it upon a surface formed of pieces of wood; 8333 if the stone was put upon a wood platform and drawn upon wood; and only 2500 men if care was taken to soap the two surfaces which slid upon each other.

The block being 52·8 feet wide, the men could easily be disposed in forty rows, which for the first case would require 250 in each row, in case they were equal, and much less if they diverged; 225 for the second; 208 for the third; and 62½ for the fourth; the last is the most practicable method.

The great breadth of this stone and its weight would make it impossible to use wooden rollers. As for those of granite, if the ground were firm and smooth enough to make use of them, 300 men or 7½ rows would have sufficed to move the load. But it is not likely that this method was adopted on account of its great expense. It is much more probable that they made use of capstans.

Supposing a simple capstan, traversed by two levers with a mean length at the point of application of the resultant force of ten times the diameter of the drum, each man makes an effort which may be valued at at 539½ lbs. If twelve men work each capstan, their effort will be 6474 lbs., which gives in the first case, when a force equal to ⅔ of load is required, 2400 men and 200 capstans.

For the second case 2160 men and 180 capstans; for the third 2000 men and 166 capstans; and for the fourth 600 men and 50 capstans.

By the use of pulleys and muffles the number of men and capstans may be reduced one-half or a quarter.

The results here shown indicate the force necessary to move the block upon a horizontal plane; but as it had to be raised above the walls of the temple which it served to cover, in raising it upon an inclined plane it is evident that the force must be increased in the ratio of its inclination. We here give upon this subject some experiments which will serve to make known the proportion of the increase of the force.

If we place a square based solid upon a right plane and the surfaces are not polished, more or less difficulty is experienced in moving it, according to the roughness of the surfaces. But if, instead of pushing the body for its motion, we incline the plane until it commences sliding, we find that it requires as much force to move a round body up this incline as to draw the square based solid upon a horizontal plane. Moreover, to haul up the square based solid upon an inclined plane, we must use a force equal to that which would cause a round body to rise upon an inclined plane as many degrees above the plane on which the square based solid began to slide, as the first plane is above the horizontal.

The force required to raise a round body upon an incline is very nearly the same as that given by theory; whence it follows if we take for the horizontal plane, that upon which a plane surface solid begins to slide, we shall have the force necessary to raise this solid upon any incline by adding to its inclination that of the plane taken for the horizontal.

Experiments.—To draw upon a lias slab placed horizontally a cube of the same material, with a face of 4·26 inches weighing 6·74 lbs., it required a force of 3·57 lbs. This cube did not begin to slide until the plane on which it stood was raised a little more than 30°. To draw up this plane a round body of the same weight and material required 3·52 lbs; the diameter of the body was 4·8 inches.

To draw the above cube upon the same plane inclined 30°, the line of traction being parallel to plane, required a force of 5·95 lbs. This force is sufficient to raise the round body upon a plane inclined 60°.

The force required to raise a round body upon inclines of 30° and 60° is very nearly equal to that given by the application of the principles of mechanics. For, in the first case, theory gives 3·37 lbs. and experiment 3·52.

For the second case theory gives 5·87 lbs., and *experiment* 5·95 lbs.

It follows from these experiments that in taking for the horizontal plane, that upon which a solid with a plane surface begins to slide, we shall find the force required to raise this solid upon any incline, by adding to the inclination of this plane, that of the plane upon which the solid begins to slide. Thus, to make an application of this rule to the great block of Buto, we will suppose the plane for carrying it above the walls was inclined at 12°. This granted, mechanics demonstrates that the force required to raise a round body upon an inclined plane is to its weight, as the height of the plane is to its length; we have found that to draw this stone upon a horizontal plane, in the first case, the necessary force was $\frac{2}{3}$ of the weight; that is to say, it answers to that required to raise a round body upon a plane of 41° 48′, to which adding the 12°, for the slope of plane on which the block is to be raised, we have 53° 48′, whose sine indicates $\frac{4}{5}$ of the weight in place of $\frac{2}{3}$.

In the second case, the force, being $\frac{3}{5}$ of the weight, answers to the sine of 36° 53′, to which adding 12°, we have 48° 53′, whose sine indicates $\frac{3}{4}$ of the weight.

For the third case, the force is $\frac{5}{9}$ of the weight, which answers to sine of 33° 45′, and of 45° 45′ in adding the 12°, whose sine indicates $\frac{7}{10}$ of the weight.

Finally, the fourth case, which exacts but $\frac{1}{6}$ of the weight, answers to the sine of 9° 36′, to which adding the 12° we have 21° 36′, whose sine indicates a force equal to $\frac{9}{25}$ of weight. Thus, by using simple capstans without muffles, there was required, in the first case, to raise the block upon an incline of 12°, 240 capstans and 2880 men.

For the second case, 225 capstans and 2700 men. For the third case, 210 capstans and 2520 men. For the fourth case, 108 capstans and 1296 men.

Making the same applications to the monolithe structure of Amasis, whose weight was 458,744 lbs., we shall find that to draw it without capstans upon a horizontal plane like that of the first case required 2444 men.

For the second case 2200 men; for the third 2037; and for the fourth 611. The description of Herodotus proves that the third method was adopted for transporting this edifice, and that no use was made of rollers or capstans. It appears that the structure was placed upon a platform of carpentry, and drawn upon pieces of wood. The same method was probably used for transporting the obelisk of Rhamesses, spoken of by Pliny, for which 20,000 men were employed. This obelisk weighed 1,618,500 lbs., including its fixtures and the armatures of carpentry required from its great weight to prevent fracture. This process would require more than 7000 men without taking account of those occupied in preparing the roads and machines, which together might require a working force of 10,000 men, and a like number for a relay.

MECHANICS, PHYSICS, AND CHEMISTRY.

*On the Construction and Durability of Steam Boilers.** By Mr. Benjamin Goodfellow, of Hyde.

The object of this paper is to communicate some circumstances and changes that have been observed by the writer to take place in the size and form of boilers at different temperatures, which affect considerably their strength and durability, by causing derangement and wear and tear to a much greater extent than he believes is generally supposed. His attention was first strongly drawn to this subject some years ago in reference to a large multitubular boiler that he constructed, 23 feet long and 6½ feet diameter, with 131 tubes, 11 feet long and 3 inches diameter each; and two similar boilers, but of smaller dimensions, with 9 feet tubes. A short time after these had been put to work, it was found that several of the tubes began to leak at both ends, although they had previously been proved up to 120 ℔s. per square inch with water pressure, when all was good and tight, and the steam pressure they worked at was only from 50 to 55 ℔s. After this leakage had been made good, it took place again in a few weeks; and this was repeated several times, both in the large and small boilers, but not to the same extent in the small ones. This led the writer to conclude that the cause was the elongation of the tubes by their being heated to a greater extent than the casing of the boiler; and this defect appears to him a serious objection in multitubular boilers with straight tubes of considerable length.

In the construction of fluid boilers of considerable length, say from 20 to 36 feet long, the writer at first adopted the plan of increasing the diameter of the flue, so as to increase the heating surface and diminish the quantity of water; bringing the flues nearer to each other, in the case of the two-flued boiler, and closer to the sides of the boiler, by making their diameter as large as could be got in. After a number of these had been got to work, several of them gave way transversely about the middle seam at the bottom, especially in cases where the boiler had been blown off for cleaning and cold water then turned in to cool it; the effect of which was that the bottom of the boiler instantly contracted in length, while the flues retained the same length, or nearly so, as when working, until the water came in contact with them, thereby necessarily throwing a great and undue strain upon every seam of the boiler, especially on the lower side, in consequence of the flues being so near the bottom of the boiler. The writer therefore concluded that it was wrong to increase the diameter of the ends of the flues, as this rendered the ends of the boiler much more rigid and less yielding to the expansion and contraction of the flues and casing, which do not take place in both simultaneously or to the same extent. In a boiler 30 feet long, the actual expansion of the barrel of the boiler amounts to nearly 1 inch in length; and when fired in the flue, the latter is elongated ¼ inch more than the casing, in consequence of its being at so much higher a temperature. The evil effects of this expansion and contraction are further augmented by the ordinary use of gusset stays, by which the ends of the boiler are stiffened and rigidly connected to the barrel. The circumstance of the boilers giving way in the middle of their length rather than in any other part, was owing, in the writer's opinion, to their being supported on a longitudinal centre wall, which divided the flues, or on two walls; when full of water, the boiler would weigh from 38 to 40 tons, and consequently there would be a great friction on the wall when the boiler was contracting; and the strain thus produced in pulling the two ends of the boiler nearer together is concentrated at the middle of its length, in addition to the strain arising from the resistance occasioned by the rigidity of the flues and gusset stays.

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* From Newton's London Journal, August, 1860.

In order to obviate these difficulties in flued boilers, and to provide for expansion and contraction taking place without much injury to the material or workmanship, the writer has been led to adopt flues with tapered ends, which give a greater amount of elasticity to the ends of the boiler; and with the same view, the gusset stays are dispensed with, so that the ends are not connected in any way with the casing, except by an angle-iron ring that unites the two together. The same plan may be carried out in a single-flued boiler, either by tapering the ends of the flue, or placing it nearer the centre of the boiler. The ends of the boiler are strengthened independently by means of T iron or "fish-back" girders riveted on each end between the casing and the flues; and there are no longitudinal stays between the two ends beyond those supplied by the flues and casing, each end plate being treated as an independent transverse girder supported round its edge. In order to strengthen the bottom of the boiler at the middle, against the strain produced in contracting by the friction of the longitudinal walls on which it is supported, two longitudinal strips of angle-iron or T iron are riveted on the inside, at about 3 feet apart, extending about two-thirds the length of the boiler. The writer has also adopted for some time a plan of strengthening flues of large diameter against collapse, by means of rings of T iron or angle-iron, riveted at suitable intervals round the outside of the flue at the joints. In these joints the two ends of the boiler plates are not brought together, but are left with a space between them equal to the thickness of the outer rib of the T iron, whereby a joint is obtained having no greater thickness of metal than a double plate at any part.

The absence of longitudinal and gusset stays in this construction of boiler does not leave the ends less strong to resist explosion than the other parts of the casing: for taking the whole circumference of both flues and casing, the sectional area of plate resisting the pressure on the ends of the boiler is 4¾ times greater than that resisting the lateral pressure in the casing; and in the upper half of the ends, where the pressure acts upon the greatest proportionate area, producing the greatest longitudinal tension, the resistance is 3½ times that offered to lateral explosion; while in the lower half of the ends, where there is the least proportionate area for the pressure to act upon, the resistance is 6½ times greater than the lateral resistance. The fact that flued boilers generally explode endways by failure of the lower part of the ends or casing—the very part which has been seen to be originally the strongest—proves that the strength of the plates at that part becomes greatly injured by the excessive strains arising from unequal expansion and contraction of the flues and the casing of the boiler.

Mr. R. B. Longridge could confirm the observations made in the paper as to the frequent injury caused to boilers by the effects of unequal strains upon different portions; but he did not agree with the opinion expressed that the construction of boiler proposed would be free from this source of injury. There was no doubt that great mischief arose in many boilers from imperfect circulation of the water. If perfect circulation could be obtained, a uniform temperature throughout the boiler would be preserved, and these evils obviated. In two-flued boilers, generally, it was a great defect that the water spaces were made exceedingly small, and the descent of the water past them was opposed by the rising current from the heated sides of the flues; so that the only place where the water could descend was at the back end, where coolest; and in a boiler of 30 feet length this downward current was not able to reach the front end. Plates had been put into the boiler sometimes, to divert the currents of water, and cause more regularity of circulation, but he doubted whether with much success. When a couple of 3 feet flues were put into a 7 feet boiler, 3 inch water spaces only could be obtained; and although there was no doubt a better combustion in a large flue, yet this involved the sacrifice of the proper width of water space for insuring due circulation in the boiler, which was a point of greater importance.

He did not agree with the mode proposed for staying boilers, and did not think it was at all advisable to dispense with both longitudinal and gusset stays; he considered that the end should not be left dependent only upon the riveting to the cylindrical shell and the flues. The girder ends of the boiler would no doubt be strong enough so long as the flues held good; but if the flues got seriously overheated at any part and fracture ensued, which was an accident that could not be absolutely guarded against, the boiler end might then give way on losing the support of the flues. In the case of boilers set upon a centre bearing wall, he did not see how the friction upon the bearing could cause such strain in expanding and contracting as sensibly to affect the durability of the plates; but the best plan of setting such boilers he considered was to support them upon cast iron saddles, in such a manner as not to be dependent for support on the brickwork forming the flues. An objectionable action was caused when the fire was not placed in the boiler flues, but below the boiler, for in that case there was a continued current rising at the sides, causing a descending current in the middle between the two flues, which made the deposit all accumulate in the triangular space between the flues and immediately over the fire: in many such cases, the plates over the fire became overheated in consequence, and fractured or strained at the joints.

Mr. Goodfellow considered the mode of fixing boilers on cast iron saddles was very good, and preferred it where a centre wall was not required for division between the flues. In respect of securing the boiler ends, he remembered a case where the end plates were increased from ½ to ¾ inch thickness, on account of the boiler leaking at the ends; but the bottom had then torn asunder, and he had suggested tapering the ends of the flues to a smaller diameter, so as to increase the area of flat plate at the boiler end, and substituting a thinner plate, for the purpose of getting more elastic action in the end plate; this had entirely removed the difficulty, and the boiler had continued at work for 1½ years since then, without any failure. He had found, by carefully measuring the end of a two-flued boiler, 28 feet long, that the front end plate was pushed outwards ⅛ inch in the centre, making it convex, each time the steam was up, and it gradually came back again on the boiler cooling; the back end of the boiler was not accessible for measurement, being within the brickwork, but both ends must have sprung nearly alike in order to cause the bulging, making altogether ¼ inch alternation in length of the flue, constantly going on in the working of the boiler. It appeared to him, then, that as this action could not be prevented, it was the best course to allow the end plates to yield to it, by leaving them elastic, and not hindering them from springing.

Mr. H. W. Harman said, that from his experience as chief inspector to the Manchester Association for the prevention of boiler explosions, he knew of no better construction than the cylindrical two-flued boiler, which was the one in most general use; but it was undoubtedly subject to the derangements pointed out in the paper, from the effects of unequal expansion and contraction. An unequal strain was caused upon the end angle-iron of the boiler from the flues being attached to the end plate so much below the centre; he had found many fractures of the end plates immediately over the angle-irons of the internal flues, caused principally by the end plates not yielding sufficiently to the elongation of the flues. There was no doubt that, if the plate were held too rigidly by gusset stays, something would have to give way to the inevitable strain from expansion; but he could not agree at all with the plan proposed of dispensing altogether with gusset and longitudinal stays. The entire omission of stays would be the opposite extreme, and he thought they ought not to be abandoned without substituting something else; the angle-iron which would then form the only tie between the end plate and shell, was unavoidably a comparatively weak form of iron from the mode of its rolling, and he feared, if such a plan were adopted, great risk of accident from inferior quality of angle-iron would ensue. He had examined boilers that had exploded, in which the whole of the angle-iron had parted along the upper portion of the boiler end.

As to the strain along the bottom of the shell, he had found the addition of T iron strips along the bottom did not prevent this, and he believed it arose entirely from want of circulation in the water. The plan of a centre wall dividing the flue, with the boiler resting upon it, he considered objectionable; for any leakage of water trickled down to that point, and was absorbed by the centre wall like a sponge, acting as a constant source of corrosion to the boiler.

Imperfect circulation of water formed, he believed, the most serious defect in boilers; and in many of the two-flued boilers this was chiefly owing to their not having a sufficient water space between the flues and shell. He had long been convinced of the importance of insuring a much better circulation of water being regularly maintained in boilers; and he contemplated effecting this by direct mechanical means.

Mr. D. Adamson thought it was certainly advisable to have the gusset stays for support to the end plates of a boiler, and he did not see that any thing could be gained by transferring all the action to one joint; but, on the contrary, there was this important disadvantage to be considered—that if a plate were bent backwards and forwards continually, it might fail ultimately, though not subjected at any one time to too severe a strain; if all the buckling action were thrown on the end plate, it would be simply a question of time as to its ultimate failure. On that account, he thought gusset stays should not be abandoned, and they served also as a good support against collapse; he should also recommend longitudinal stays to be retained in addition, for relieving the strain upon the boiler end joints and the circular seams of the boiler shell.

The Chairman said, he had two-flued boilers at his works, that had been in constant use for fifteen years, and no repairs had been wanted to them yet, and he had found them completely satisfactory; but then he never used angle-iron in the construction of such boilers, considering there was not space enough for the plate to spring with the additional thickness of the angle-iron. The plates of the shell, and the flues, were all flanched over at the ends for riveting to the end plates, requiring, of course, best material for the plates; the water spaces he made never less than 6 inches, and preferred 8 inches; this construction gave great flexibility to the ends of the boiler, and there was no danger of failure, he believed, until the boiler was actually worn out with age.

A Course of Lectures, consisting of Illustrations of the Various Forces of Matter, i.e. *of such as are called the Physical or Inorganic Forces.**

By M. Faraday, D. C. L., F. R. S.

Lecture V. (Jan. 6, 1860.)—*Magnetism.—Electricity.*

I wonder whether we shall be too deep to-day or not. Remember, that we spoke of the attraction by gravitation of *all* bodies to all bodies by their simple approach. Remember, that we spoke of the attraction of particles of the *same* kind to each other,—that power which keeps them together in masses,—iron attracted to iron, brass to brass, or water to water. Remember, that we found, on looking into water, that there were particles of two different kinds attracted to each other; and this was a great step beyond the first simple attraction of gravitation; because here we deal with attraction between *different* kinds of matter. The hydrogen could attract the oxygen and reduce it to water, but it could not attract any of its own particles, so that there we obtained a first indication of the existence of *two* attractions.

To-day we come to a kind of attraction even more curious than the last, namely, the attraction which we find to be of a double nature—of a curious and dual nature. And I want first of all to make the nature of this doubleness clear to you. Bodies are sometimes endowed with a wonderful attraction, which is not found in them in their ordinary state. For instance, here is a piece of shellac, having the attraction of gravitation, having the attraction of cohesion, and if I set fire to it, it would have the attraction of chemical affinity to the oxygen in the atmosphere. Now all these powers we find *in* it as if they were parts of its substance; but there is another property which I will try and make evident by means of this ball, this bubble of air [a light india-rubber ball, inflated and suspended by a thread]. There is no attraction between this ball and this shellac at present; there may be a little wind in the room slightly moving the ball about, but there is no attraction. But if I rub the shellac with a piece of flannel [rubbing the shellac, and then holding it near the ball], look at the attraction which has arisen out of the shellac, simply by this friction, and which I may take away as easily by drawing it gently through my hand. [The Lecturer repeated the experiment of exciting the shellac, and then removing the attractive power by drawing it through his hand.] Again you will see I can repeat this experiment with another substance; for f I take a glass rod and rub it with a piece of silk covered with what we call amalgam, look at the attraction which it has, how it draws the ball towards it; and then, as before, by quietly rubbing it through the hand, the attraction will be all removed again to come back by friction with this silk.

But now we come to another fact. I will take this piece of shellac, and make it attractive by friction; and remember that whenever we get an attraction of gravity, chemical affinity, adhesion, or electricity as in this case), the body which attracts is attracted also, and just as much as that ball was attracted by the shellac, the shellac was attracted by the ball. Now I will suspend this piece of excited shellac in a little paper stirrup, in this way (Fig. 1), in order to make it move easily, and I will take another piece of shellac, and after rubbing it with flannel, will bring them near together: you will think that they ought to attract each other, but now what happens? It does not attract; on the contrary, it very strongly *repels*, and I can thus drive it round to any extent. These therefore, repel each other, although they are so strongly attractive—repel each other to the extent of driving this heavy piece of shellac round and round in this way. But if I excite this piece of shellac as before, and take this piece of glass and rub it with silk and then bring them near, what think you will happen? [The Lecturer held the excited glass near the excited shellac, when they attracted each other strongly.] You see, therefore, what a difference there is between these two attractions,—they are actually two *kinds* of attraction concerned in this case, quite different to any thing we have met with before; but the *force* is the same. We have here then a double attraction—a dual attraction or force—one attracting and the other repelling.

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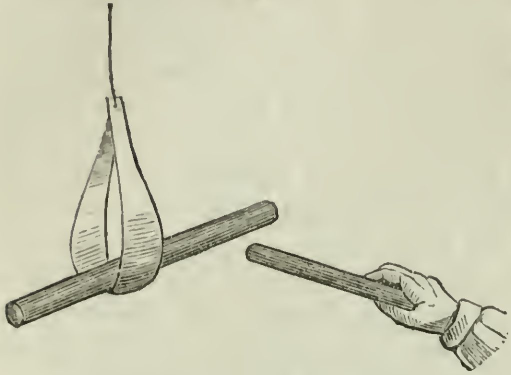
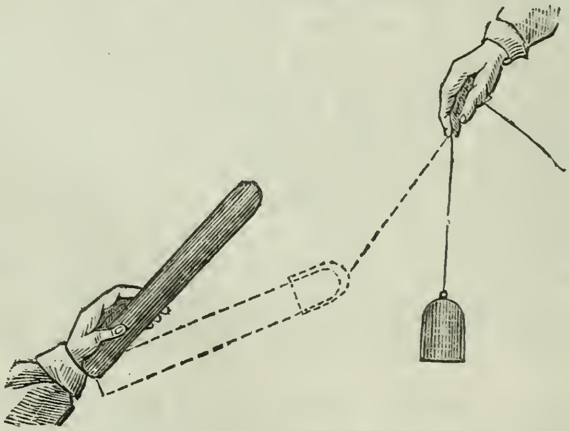
* From the Lond. Chemical News, No. 9.

Fig. 1.



Again, to show you another experiment which will help to make this clear to you. Suppose I set up this rough indicator again [the excited shellac suspended in the stirrup]; it is rough, but delicate enough for my purpose; and suppose I take this other piece of shellac, and take away the power, which I can do by drawing it gently through the hand; and suppose I take a piece of flannel (Fig. 2) which I have shaped into a cap for it, and made dry. I will put this shellac into the flannel, and here comes out a very beautiful result. I will rub this shellac and the flannel together (which I can do by twisting the shellac round), and leave them in contact; and then if, I ask, by bringing them near our indicator, what is the attractive force? it is nothing! But if I

Fig. 2.



take them apart, and then ask what will they do when they are separated,—why the shellac is strongly repelled, as it was before, but the cap is strongly attractive; and yet if I bring them both together again, there is no attraction—it has all disappeared [the experiment was repeated]. Those two bodies therefore still contain this attractive power—when they were parted it was evident to your senses that they had it, though they do not attract when they are together.

This, then, is sufficient in the outset to give you an idea of the nature of the force which we call ELECTRICITY. There is no end to the things from which you can evolve this power. When you go home take a stick of sealing-wax—I have rather a large stick, but a smaller one will do—and make an indicator of this sort (Fig. 3). Take a watch-glass (or your watch itself will do, you only want something which shall have a round face), and now if you place a piece of flat glass upon that, you have a very easily moved centre; and if I take this lath and put it on the flat glass (you see I am searching for the centre of gravity of this lath, I want to balance it upon the watch-glass), it is very easily moved round, and if I take this piece of sealing-wax and rub it against my coat, and then try whether it is attractive [holding it near the lath], you see how strong the attraction is; I can even draw it about. Here, then, you have a very beautiful indicator, for I have with a small piece of sealing-wax and my coat pulled round a plank of that kind, so you need be in no want of indicators to discover the presence of this attraction. There is scarcely a substance which we may not use. Here are some indicators (Fig. 4). I bend round a strip of paper into a hoop and we have as good an indicator as can be required; see how it rolls along, traveling after the sealing-wax. If I make them smaller, of course we have them running faster, and sometimes they are actually attracted up into the air. Here also is a little collodion balloon. It is so electrical that it will scarcely leave my hand unless to go to the other. See how curiously electrical it is; it is hardly possible for me to touch it without making it electrical; and here is a piece which clings to any thing it is brought near, and which it is not easy to lay down. And here is another substance, gutta-percha, in thin strips; it is astonishing how by rubbing this in your hands you make it electrical; but our time forbids us to go farther into this subject at present; you see clearly there are two kinds of electricities which may be obtained by rubbing shellac with flannel or glass with silk.

Fig. 3.

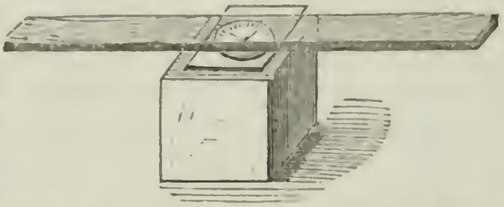
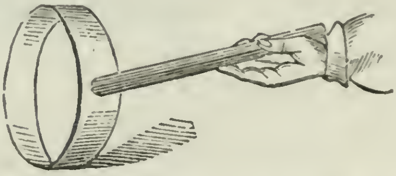


Fig. 4.



Now there are some curious bodies in nature (of which I have two specimens on the table) which are called *magnets* or *loadstones;* ores of iron, of which there is a great deal sent from Sweden. They have the attraction of gravitation, and attraction of cohesion, and certain chemical attraction; but they also have a great attractive power, for this little key is held up by this stone. Now, that is not chemical attraction, it is not the attraction of chemical affinity, or of aggregation of particles, or of cohesion, or of electricity (for it will not attract this ball if I bring it near it), but it is a separate and dual attraction, and what is more, one which is not readily removed from the substance, for it has existed in it for ages and ages in the bowels of the earth. Now we can make artificial magnets (you will see me to-morrow make artificial magnets of extraordinary power). And let us take one of these artificial magnets, and examine it, and see where the power is in the mass, and whether it is a dual power. You see it attracts these keys, two or three in succession, and it will attract a very large piece of iron. That then is a very different thing indeed to what you saw in the case of the shellac, for *that* only attracted a light ball, but here I have several ounces of iron held up. And if we come to examine this attraction a little more closely, we shall find it presents some other remarkable differences; first of all, one end of this bar (Fig. 5) attracts this key, but the middle does not attract. It is not then the *whole* of the substance which attracts. If I place this little key in the middle it does not adhere; but if I place it *there*, a little nearer the end, it does, though feebly. Is it not then very curious to find that there is an attractive power at the extremities which is not in the middle?—to have thus in one bar two places in which this force of attraction resides. If I take this bar and balance it carefully on a point so that it will be free to move round, I can try what action this piece of iron has on it. Well, it attracts one end, and it also attracts the other end, just as you saw the shellac and the glass did, with the exception of its not attracting in the middle. But if now, instead of a piece of iron, I take a *magnet*, and examine it in a similar way, you see that one of its ends *repels* the suspended magnet; the force then is no longer attraction but repulsion; but, if I take the other end of the magnet and bring it near, it shows attraction again.

Fig. 5.

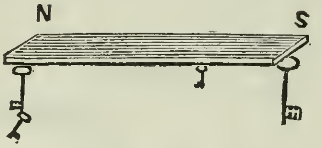
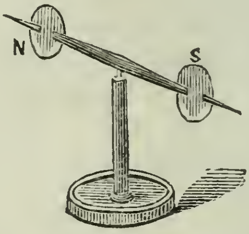


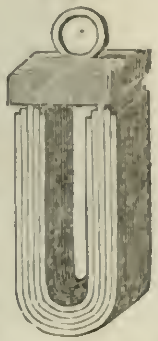
Fig. 6.



You will see this better, perhaps, by another kind of experiment. Here (Fig. 6) is a little magnet, and I have colored the ends differently so that you may distinguish one from the other. Now this end (. . . .) of the magnet (Fig. 5) attracts the *uncolored* of the little magnet. You see it pulls it towards it with great power. And as I carry it round, the uncolored end still follows. But now if I gradually bring the middle of the bar magnet opposite the uncolored end of the needle, it has no effect upon it, either of attraction or repulsion, until, as I come to the opposite extremity (. . . .) you see that it is the *colored* end of the needle which is pulled towards it. We are now therefore dealing with two kinds of power, attracting different ends of the magnet—a double power, already existing in these bodies, which takes up the form of attraction and repulsion. And now when I put up this label with the word MAGNETISM, you will understand that it is to express this double power.

Now with this loadstone you may make magnets artificially. Here is an artificial magnet (Fig. 7) in which both ends have been brought together in order to increase the attraction. This mass will lift that lump of iron, and what is more, by placing this *keeper*, as it is called, on the top of the magnet, and taking hold of the handle, it will adhere sufficiently strongly to allow itself to be lifted up, so wonderful is its power of attraction. If you take a needle, and just draw one of its ends along one extremity of the magnet, and then draw the other end along the other extremity, and then gently place it on the surface of some water (the needle will generally float on the surface, owing to the slight greasiness communicated to it by the fingers), you will be able to get all the phenomena of attraction and repulsion, by bringing another magnetized needle near to it.

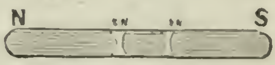
Fig. 7.



I want you now to observe that although I have shown you in these magnets that this double power becomes evident principally at the extremities, yet the *whole* of the magnet is concerned in giving the power.

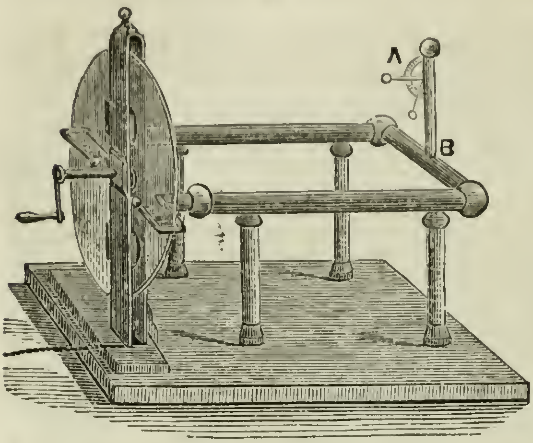
That will at first seem rather strange, and I must therefore show you an experiment to prove that this is not an accidental matter, but that the whole of the mass is really concerned in this force, just as in falling the whole of the mass is acted upon by the force of gravitation. I have here (Fig. 8) a steel bar, and I am going to make it a magnet by rubbing it on the large magnet (Fig. 7). I have now made the two ends magnetic in opposite ways. I do not at present know one from the other, but we can soon find out. You see when I bring it near our magnetic needle (Fig. 6) one end repels and the other attracts; and the middle will neither attract nor repel—it *cannot*, because it is *half-way between the two ends.* But now, if I break out that piece (*n. s.*) and then examine it—see how strongly one end (*n*) pulls at this end (S, Fig. 6) and how it repels the other end (N). And so it can be shown that every part of the magnet contains this power of attraction and repulsion, but that the power is only rendered evident at the end of the mass. You will understand all this in a little while, but what you have now to consider is that every part of this steel is in itself a magnet. Here is a little fragment which I have broken out of the very centre of the bar, and you will still see that one end is attractive and the other is repulsive. Now, is not this power a most wonderful thing? And very strange, the means of taking it from one substance and bringing it to other matters. I cannot make a piece of iron or any thing else heavier or lighter than it is; its cohesive power

Fig. 8.



it must and does have; but as you have seen by these experiments, we can add or subtract this power of magnetism, and almost do as we like with it.

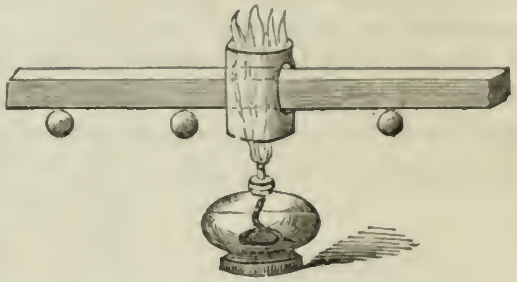
Fig. 9.



And now we will return for a short time to the subject treated of at the commencement of this lecture. You see here (Fig. 9) a large machine got up for the purpose of rubbing glass with silk and for obtaining the power called *electricity;* and the moment the handle of the machine is turned a certain amount of electricity is evolved, as you will see by the rise of the little straw indicator (. . . .). Now I know from the appearance of repulsion of the pith ball at the end of the straw that the electricity is present in those brass conductors (. . . .), and I want you to see the manner in which that electricity can pass away [touching the conductor (. . .) with his finger, the Lecturer drew a spark from it, and the straw electrometer immediately fell]. There, it has all gone; and that I have really taken it away you shall see by an experiment of this sort. If I hold this cylinder of brass by the glass handle and touch the conductor with it I take away a little of the electricity. You see the spark in which it passes, and observe that the pith ball indicator has fallen a little, which seems to imply that so much electricity is lost; but it is not lost, it is here in this brass, and I can take it away and carry it about, not because it has any substance of its own, but by some strange property which we have not before met with as belonging to any other force. Let us see whether we have it here or not. [The Lecturer brought the charged cylinder to a jet from which gas was issuing; the spark was seen to pass from the cylinder to the jet, but the gas did not light.] Ah! the gas did not light, but you saw the spark; there is perhaps some draft in the room which blew the gas on one side, or else it would light; we will try this experiment afterwards. You see from the spark that I can transfer the power from the machine to this cylinder, and then carry it away and give it to some other body. You know very well as a matter of experiment that we can transfer the power of heat from one thing to another; for if I put my hand near the fire it gets hot. I can show you this by placing before us this ball which has just been brought red-hot from the fire. If I press this wire to it some of the heat will be transferred from the ball, and I have only now to touch this piece of gun-cotton with the hot wire and you see how I can transfer the heat from the ball to the wire and from the wire to the cotton. So you see that some powers are transferable and others are not. Observe how long the heat stops in this ball. I might touch it with the wire, or with my finger, and if I did so quickly, I should merely burn the surface of the skin; whereas if I touch that cylinder however rapidly with my finger the electricity is gone at once—dispersed on the instant, in a manner wonderful to think of.

I must now take up a little of your time in showing you the manner in which these powers are transferred from one thing to another; for the manner in which *force* may be conducted or transmitted is extraordinary, and most essential for us to understand. Let us see in what manner these powers travel from place to place. Both heat and electricity can be conducted; and here is an arrangement I have made to show how the former can travel. It consists of a bar of copper (Fig. 10), and if I take a spirit-lamp (this is one way of obtaining the power of heat) and place it under that little chimney, the flame will strike against the bar of copper and keep it hot. Now you are aware that power is being transferred from the flame of that lamp to the copper, and you will see by-and-by that it is being conducted along the copper from particle to particle; for, inasmuch as I have fastened these wooden balls by a little wax at particular distances from the point where the copper is first heated, first one ball will fall and then the more distant ones, as the heat travels along, and thus you will learn that the heat travels gradually through the copper. You will see that this is a very slow conduction of power as compared with electricity. If I take cylinders of wood and metal joined together at the ends and wrap a piece of paper round and then apply the heat of this lamp to the place where the metal and wood join, you will see how the heat will accumulate where the wood is, and burn the paper with which I have covered it; but where the metal is beneath the heat is conducted away too fast for the paper to be burned. And so if I take a piece of wood and a piece of metal joined together, and put it so that the flame shall play equally both upon one and the other, we shall soon find that the metal will become hot before the wood; for if I put a piece of phosphorus on the wood, and another piece on the copper, you will find that the phosphorus on the copper will take fire before that on the wood is melted; and this shows you how badly the wood conducts heat. But with regard to the traveling of electricity from place to place its rapidity is astonishing. I will, first of all, take these pieces of glass and metal, and you will soon understand how it is that the glass does not lose the power which it acquired when it is rubbed by the silk; by one or two experiments I will show you. If I take this piece of brass and bring it near the machine, you see how the electricity leaves the latter and passes to the brass cylinder. And again, if I take a rod of metal and touch the machine with it I lower the indicator, but when I touch it with a rod of glass no power is drawn away, showing you that the electricity is conducted by the glass and the metal in a manner entirely different; and to make you see that

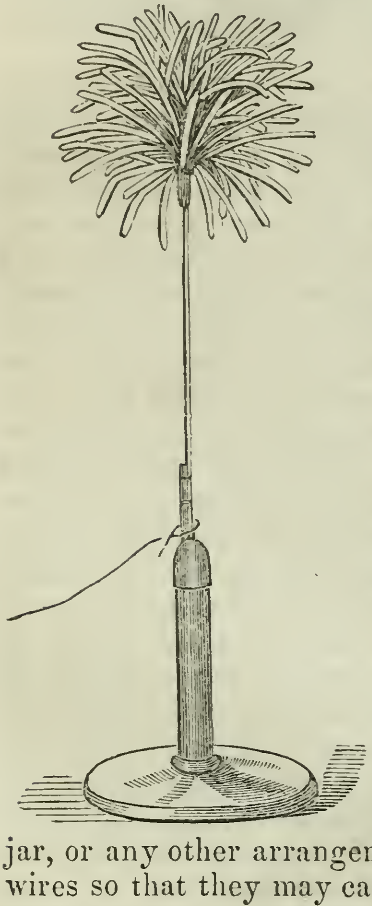
Fig. 10.



more clearly we will take one of our Leyden jars. Now, I must not embarrass your minds with this subject too much, but if I take a piece of metal and bring it against the knob at the top and the metallic coating at the bottom you will see the electricity passing through the air as a brilliant spark. It takes no sensible time to pass through this, and if I were to take a long metallic wire, no matter what the length, at least as far as we are concerned; and if I make one end of it touch the outside and the other touch the knob at the top—see how the electricity passes!—it has flashed instantaneously through the whole length of this wire. Is not this different from the transmission of heat through this copper bar (Fig. 10), which has taken a quarter of an hour or more to reach the first ball?

Here is another experiment, for the purpose of showing the conductibility of this power through some bodies and not through others. Why do I have this arrangement made of brass? [pointing to the brass work of the electrical machine, Fig. 9.] Because it conducts electricity. And why do I have these columns made of glass? Because they obstruct the passage of electricity. And why do I put that paper tassel (Fig. 11) at the top of the pole, upon a glass rod, and connect it with this machine by means of a wire? You see at once that as soon as the handle of the machine is turned the electricity which is evolved travels along this wire and up the wooden rod, and goes to the tassel at the top, and you see the power of repulsion with which it has endowed these strips of paper, each spreading outwards to the ceiling and sides of the room. The outside of that wire is covered with gutta percha; it would not serve to keep the force from you if you touched it with your hands, because it would burst through, but it answers our purpose for the present. And so you see how easily I can manage so as to send this power of electricity from place to place by choosing the materials which can conduct the power. Suppose I want to fire a portion of gunpowder, I can readily do it by this transferable power of electricity. I will take a Leyden jar, or any other arrangement which gives us this power, and arrange wires so that they may carry the power to the place I wish; and then placing a little gunpowder on the extremities of the wires, the moment I make the connexion by this discharging rod, I shall fire the gunpowder [the connexion was made and the gunpowder ignited]. And if I were to show you a stool like this, and were to explain to you its construction, you could easily understand that we use glass legs because these are capable of preventing the electricity from going away

Fig. 11.



to the earth. If, therefore, I were to stand on this stool and receive the electricity through this conductor I could give it to any thing that I touched. [The Lecturer stood upon the insulating-stool and placed himself in connexion with the conductor of the machine.] Now I am electrified, I can feel my hair rising up as the paper tassel did just now. Let us see whether I can succeed in lighting gas by touching the jet with my finger. [The Lecturer brought his finger near a jet from which gas was issuing, when after one or two attempts the spark which came from his finger to the jet, set fire to the gas.] You now see how it is that this power of electricity can be transferred from the matter in which it is generated, and conducted along wires and other bodies, and thus be made to serve new purposes utterly unattainable by the powers we have spoken of on previous days; and you will not now be at a loss to bring this power of electricity into comparison with those which we have previously examined, and to-morrow we shall be able to go farther into the consideration of these transferable powers.

(To be Continued.)

*Steam Boiler Explosions.** By J. W. Clare, C. E.

I have devoted considerable attention for many years to the causes of steam boilers exploding, and in collecting data to form more definite rules to judge of their strength and capabilities. It is a fact not generally known, that boiler breakers are much better acquainted with the causes of steam boiler explosions than boiler makers, and it should be more generally known by the public that there is no mystery whatever in the case, but that they arise simply from causes that may easily be avoided or prevented. Some eighteen years since, I came to the conclusion that, as medical men obtained an insight as to the causes of diseases in the human system during life, by dissecting and examining the body after death, I would adopt the same plan with old steam boilers of all classes, and especially those which had exploded, to arrive at better remedies for their general defects and weakness. With this view, I have repeatedly scraped off the rust from several places on the outside, and the scale also from the inside, of all descriptions of old steam boilers, and then watched their being broken up, and examined the plates afterwards; and from this experience, combined with general observation at various boiler makers, and of a large number in use, I have formed the following conclusions:—

First, from the competition among boiler makers to undersell each other a great deal of plate and angle-iron has been used in the construction of boilers that is quite unfit for the purpose; for all boiler iron should be effectually piled different ways before being placed in the furnace, to ensure the fibre or grain of the iron extending in all directions in the plane of the surface.

Secondly, that punching out one-third of the iron down the sides of the plates, with the grain of the metal, driving into these holes a steel drift, to force them opposite to each other, and then driving the inner edge of the plate under with steel caulking irons, all tends to granulate and strain the metal left between the rivets. Whereas, if the holes were all drilled through both the plates at once, and arranged to form a double zigzag line, and a slip of spun yarn and white lead, or other suitable packing, laid in between the two lines of rivets, much less caulking would be sufficient, and these joints, and consequently the whole boiler, could be more securely depended upon. And as by inspecting the plates we could form more correct opinions as to the strength of boilers than we can by the present plan of putting them together, I have continually found the metal between the holes so much deteriorated, that sharp blows with a sledge-hammer would split several of them into each other; and I have carefully sawn out thin strips of the metal from between the holes and compared them with similar pieces from other parts of the same plate, and invariably found the metal from between the holes was more brittle than any other. And I have always found that where plates had been drilled and bolted on with bolts and nuts for patches on old boilers, the metal between the holes was not injured. I have also found, that where patches were riveted on and caulked, the metal between the holes in the boiler was much more deteriorated than that between the holes of the patch; and from this I have inferred, that after boiler-paltes have been acted upon by heat and oxidation they will not bear being hammered without greatly reducing their power of adhesion along the line over which the hammer has been used.

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*From the London Engineer, No. 235.

Thirdly, many large boilers are worked up to a higher pressure than formerly, in proportion to their weight and strength, being hard fired to a power beyond their capabilities. When do we hear of a steam boiler exploding among the hundreds of small boilers used by shopkeepers and others in a small way of business, who have not sufficient work to strain them?

Fourthly, many manufacturers use their boilers too long a time for safety; I have frequently seen different parts of plates in old boilers, less than one-eighth of an inch thick, and in other cases the metal of the plates so perished, as not to bear being bent to a greater angle than 30 deg. without fracture. From this I argue that while the strain upon a boiler-plate continues in one direction, it may be worked until worn to within one-half its original thickness without risk of explosion at the usual working pressure; but that if any thing occurs to bend or twist the grain of the metal, either by hammering, unequal expansion or contraction, or any other cause, the limit of elasticity is so greatly reduced as to render it incapable to withstand the usual direct strain. And lastly, boilers frequently leak unperceived into one of the flues, and oxidation goes on more rapidly than usual. I will pass over such causes as malconstruction, negligence, wilfulness, &c., and merely observe, in conclusion, that if all persons were compelled to inform a competent surveyor when they fixed a new boiler, and it was his duty to go and examine it, keep an account of the date, and have the power of condemning it if unsafely constructed, as also the power to go and examine it whenever he thought proper, and of condemning it when it was worn or had become dangerous to public safety: the users of steam boilers might in time be taught that it was entirely to their own interest to have a boiler of the best material and the best construction, such boilers being ultimately, when all expenses are considered, invariably the least expensive.

2, Surrey-square, S. E., June 26, 1860.

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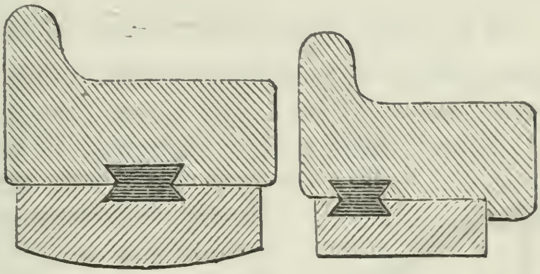
*Fastening Railway Wheel Tires.** By J. C. Pearce.

The consequences resulting from the ordinary defective method of fastening the tires of railway wheels having again recently drawn some attention to the subject, induces me to offer to your notice a new plan, patented some two years ago by Mr. E. Turner, of the Bowling Iron Company, in conjunction with myself, which, though but comparatively little known, is unquestionably the most perfect fastener in use. It presents no difficulties to be overcome in the formation of the tire and wheel-rim, neither is its application confined to any particular section of tire, &c.; but, on the contrary, its simplicity renders it easily applied to all.

A dovetailed groove is formed around the inner surface of the tire, corresponding with a similar groove formed around the wheel-rim, as shown in the accompanying illustrations. The tire, after being shrunk on the wheel in the usual way, is turned and finished so as to allow ample opportunity for the detection of bad welding or other imperfection. The wheel is then placed in an horizontal position, and the double dovetailed ring is cast into the grooves through holes, similar to rivet holes, in the wheel-rim. The ring thus formed constitutes a continuous rivet all round the wheel, holding both rim and tire firmly together, and rendering it impossible for the latter to get out of position in the event of fracture.



The plan here described is applied to engine and carriage wheels, and has been in successful operation more than two years. Various interests and prejudices will doubtless delay its general adoption, but it is gradually working its way into favor.

There should be no excuse to shield railway companies from the responsibility of accidents arising from the fracture of wheel tires while they possess the means of rendering such accidents perfectly harmless, if not impossible.

July 16, 1860.

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* From the Lond. Mechanics' Mag., July, 1860.

Determination of Organic Matter in Water.

M. Emile Monnier presented to the Academy of Sciences of Paris, an interesting note on the determination of the organic matters in the waters of the Seine. The re-agent which he employs is the per-manganate of potassa. The weight of this salt decomposed being sensibly proportional to that of the organic matter, the problem is reduced to the determination of the weight of per-manganate decolored by a given quantity of the water.

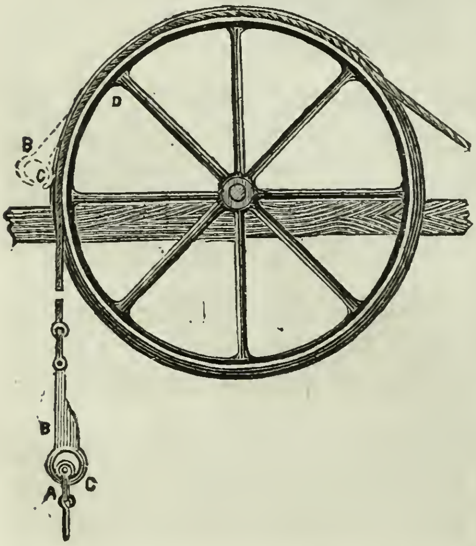
The test-liquor which he employs is prepared by dissolving one gramme of pure per-manganate in one litre of distilled water; each cubic centimetre of this liquid contains one milligramme of the salt. To perform an analysis proceed as follows:

Pour into a matrass a half-litre (about a pint) of the water and bring it to the temperature of 158° F.; add through a pipette 1 cubic centimetre of pure sulphuric acid; then add the test-liquor until a permanent coloration is produced; the number of cubic centimetres of this liquor added, gives at once in milligrammes the weight of the re-agent decomposed by one litre of water. At about 158° F. the decomposition of the organic matters is rapid; at common temperatures it would require more than 24 hours to be complete.

The sensibility of the per-manganate is very great; one gramme of tannin in 2 cubic metres (or one part of tannin to two million parts of water) and even one part by weight of sulphuretted hydrogen in eleven million parts of water will discolor it.—*Cosmos.*

On a Self-acting Disengaging Hook.[*]

The frequency and fatal consequences of accidents arising from over winding or drawing the cage over the head gear pulley, have called the attention of colliery owners and inspectors to the means whereby such accidents may be avoided in future. The annexed engraving represents a self-acting spring hook, the invention of Mr. Robert Walker, of Eccleston, near Prescot, colliery viewer. This hook possesses all the qualities requisite to insure its general application in coal and other mines. When this hook is employed, it is impossible to wind the cage up sufficiently high to cause an accident. The mode of action is as follows:—When the cage is rising, the bridle, A, hangs in the hook, B, which is made with a spring catch, C. This catch closes the hook entirely, so that there is no possibility of the cage becoming disengaged in winding; but if, owing to the neglect of



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[*] From the Lond. Practical Mechanic's Journal, August, 1860.

the engine driver, or from any other cause, the cage should be raised until the hook comes against the head gear pulley, D, as shown by the dotted lines, then the hook assumes a diagonal position, and the bridle, A, bearing upon the spring catch, C, causes it to open and to disengage the cage from the hook. When the cage is disengaged it is caught by retaining pawls or other apparatus, to prevent it descending the pit.

For the Journal of the Franklin Institute.

Binocular Vision, Theory of Images on Transparent Media, and the Stereomonoscope. By C. J. W., Jr.

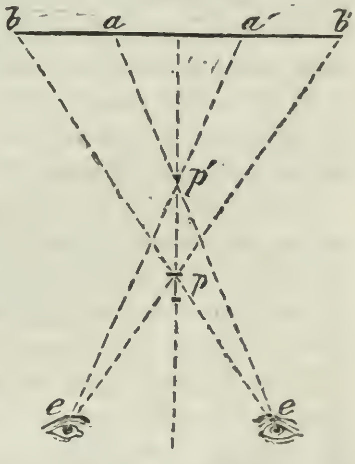
The laws of optics and of binocular vision are so well understood and have been so thoroughly investigated that any detailed recapitulation of them in this place would be supererogatory. It will, therefore, be necessary merely to allude to such as may have a direct bearing upon the subjects treated of in this article.

In viewing a landscape which possesses the advantage of a variety of planes of distance, first with both eyes simultaneously, and then with the right and left eye alternately, we shall perceive that in all these three instances, near and distant objects occupy different relative positions with regard to each other.

In the latter case, where the view is with either eye alternately, near objects will appear to have moved with regard to more distant ones, to the right when the right eye is closed and to the left when the left eye is closed.

Of course the reverse is the case when distant objects are viewed with regard to near ones. The amount of apparent motion will be in proportion to the relative direct distances of the observer from the objects viewed and of the objects from each other. In case, however, of vision with the eyes simultaneously, when the optic axes are directed to any point it will not appear in either of the positions to which it has been referred by the eyes separately, but will assume an intermediate one.

Fig. 1.



If ee (Fig. 1) represent the eyes, it will be seen that by closing them alternately, the near point p will have an apparent motion bb' when referred to that line; while the more distant point p' will only have an apparent motion aa' when referred to the same line; whereas if both eyes be turned to the points p, p' respectively, they will occupy an intermediate position between these two extremes.

When the optic axes are converged upon distant points, indistinct duplicate images of nearer points will be visible, separated in proportion to their proximity to the observer, and occupying the positions to the right and to the left respectively which they occupied when viewed with either eye alternately, and *vice versa*, when the optic axes are directed to near points, distant ones are then duplicated and occupy the positions in which they were seen when viewed with the eyes successively. If the head is held out of the perpendicular so that a line joining the eyes shall not be a horizontal line, and the eyes fixed upon a distant point, the two images of a near point received by them will likewise be unequally elevated; that image being most depressed which is seen by the eye that is most elevated, and *vice versa*, that image most elevated which is seen by the eye that is most depressed.

All these phenomena are in perfect harmony with the law of visible direction, the integrity of which is preserved throughout. In the cases last alluded to, the elevated eye receiving the image by virtue of an ascending ray, and in obedience to this law, seeing it in a direction perpendicular to a plane tangent to the retina at the point of contact of this incident ray, receives the impression of a less elevated object. The other eye, however, perceiving the image by a ray less inclined, receives the impression of a more elevated object. The rays in both instances issuing from the same object, though entering the eyes with different degrees of inclination.

If we now, with a binocular camera properly constructed, having its lenses equally separated with the eyes of the observer, take photographic pictures of the objects before us and look at them with the assistance of the stereoscope, we shall be able to repeat all the experiments above suggested with the same results as when we were viewing the natural objects whose fac similes we are now in possession of.

These two dissimilar perspectives, taken at points two and a half inches distant, faithfully represent the right and left hand monocular views, and by alternately closing the right and left eye, near and distant objects will undergo changes in their relative position, precisely as they were seen to do in our natural vision of the landscape.

It is to the coincidence of these two dissimilar perspectives, effected by different degrees of convergency of the optic axes, that the stereoscopic illusion of solidity and relief is to be ascribed.

Allied to this in result, though effected through various ocular processes, are many other phenomena of vision, classified under the general title of optical illusions. Among the most noticeable of these is the relief produced by the copying of medals and other raised surfaces by the ruling machine.

This, like the one under discussion, is but another form of the projection of solids upon flat surfaces, the elevations and depressions of the medal corresponding with the different planes of distance of the stereoscopic object; and the effect of the deviation of parallel lines from their original parallelism in coming in contact with planes placed at all varieties of angles and of unequal elevations, in the one case, corresponding with the effect of the combination of dissimilar perspectives in the other.

This illusion of relief might also be in a measure produced, or at least enhanced, by calling into requisition the power of focal adjustment of the eye in connexion with the different degrees of refrangibility of the prismatic colors. By giving objects intended to appear in relief that color whose ray is least refrangible, and those intended to recede from the eye, that color whose ray is most refrangible, we should invest them with at least one attribute of proximity and distance. In the former case the less refrangible ray would correspond in focal adjustment with the diverging rays of near objects, while in the latter case the more refrangible rays would correspond in focus with parallel rays of distant objects.

To this different degree of refrangibility of the prismatic rays may be ascribed the peculiarly unpleasant dazzling effect experienced in passing the eyes rapidly over certain combinations of colors. If the extremes of the solar spectrum representing the maximum and minimum of refrangibility be rapidly and consecutively presented to the eyes, each requiring a different focal adjustment to produce distinct vision, it can easily be conceived that the effect would be dazzling and confused.

In these latter instances the illusion would evidently be much more perfect if one eye alone were used; convergency now coming to our aid as a most powerful adjunct in dispelling an illusion, which, in the first case cited,—that of the stereoscope—it was exclusively instrumental in producing.

All these cases afford striking instances of the liability to error incurred by implicit reliance upon the evidence of any one witness, however perfect in itself; truth is only to be established by the concurrent testimony of all those with which nature has provided us for protection from deception and imposture, and for our better acquaintance with the works with which she has surrounded us.

We will now lay aside the photographic representations of the landscape, and with the aid of the stereoscope examine the images themselves as they appear depicted upon the ground glass of our binocular camera. In so doing a most unexpected and illusive effect will be produced.

All our previous knowledge of the distances of the various objects in view, is now completely at variance with the confused and illusive evidence of our senses.

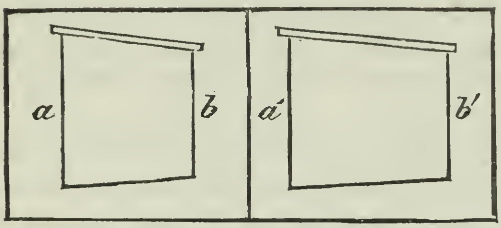
We know, for example, that the sky is far more distant than the trees, and yet are small blue patches of it boldly protruding through apertures of the foliage and advancing into the foreground, while trees and their branches, known to be almost within our grasp, are modestly retiring and hiding themselves behind the distant skies. In fact, some potent spell appears suddenly to have inverted the entire order of things. Trunks of prominent trees seem to be sinking into, and almost enveloped by foliage that is behind them. Shadowy visions of leaves yielding to the breeze appear to pass behind the branches which they are actually placed in advance of, and which appear to have become magically endowed with transparency for the accommodation of the observer. In a word, the illusion is complete. All distant objects appear at hand, and all near objects far, in proportion to their proximity.

If Sir David Brewster's theory of the stereoscope required another proof of its correctness, it would be found in this simple and interesting experiment; and it is a little singular that he makes no allusion to it in his work on that subject. In the case before us we find nearly all the elements essential to the formation of correct estimates of distance, such as magnitude, definition, perspective, &c., arrayed in direct antagonism to one solitary test, which is left to rebut their testimony single-handed and alone. It is that most essential element of vision, convergency, and although but one against many, it proves too strong for them all. For it is only by previous knowledge of the position of the objects of the landscape, or through some other means of information than the present modified form of vision affords, that we are enabled to dispel the illusion under which we labor, and be reassured of the actual order of nature.

A key to the mystery, however, is at hand. It will be found by analyzing the dissimilar perspectives projected upon the ground glass, that our lenses in inverting each picture separately have also inverted or rather reversed the relative horizontal separation of similar points of the various planes of distance upon which the stereoscopic effect depends.

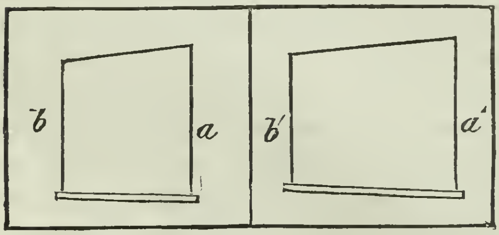
Similar points of near planes will now be found to be more distantly separated than similar points of distant planes. Whereas, in the erect pictures drawn from nature the reverse is the case, similar points of near planes being nearer than those of distant planes.

Fig. 2.



Suppose *a b* and *a′ b′* (Fig. 2) to represent dissimilar perspectives of an object as seen by ordinary vision with the right and left eye alternately—*a a′* represent similar points of near planes, while *b b′* represent similar points of distant planes; *b b′* being more distant from each other than *a a′*. Now suppose these two perspectives to be separately inverted as they are by the lenses of a binocular camera; their position will then be as in Fig. 3. It will there be seen that the lines *b*, *b′*, which were in the first case more distant than *a*, *a′*, now more nearly approach each other. Consequently upon application of the stereoscope to the first pair of dissimilar perspectives, points of near planes will be converged near to the eyes, and points of distant planes more distantly, following the course of natural vision, in which near points require a greater degree of convergency than distant ones.

Fig. 3.



With the latter pictures, however, the reverse is the case. For similar points of near planes being more separated will be converged at a greater distance than similar points of distant planes. Thus reversing the order of nature and producing that confusion and inversion of distances already described.

These perspectives reversed as they now appear on the ground glass of the camera, are in a proper position to produce a correct impression combined ocularly without the intervention of the stereoscope, provided the image is formed before and not beyond the ground glass; for in that case the greater the separation of corresponding points of perspective, the more nearly to the observer will the points of their coincidence be approached. The image that results from this combination will be diminished in size in proportion as it approaches the eye. Our estimate of its dimensions being formed by the conviction that convergency affords of its increased proximity, together with the impression on the retina, which shows that it subtends the same visual angle, the deduction is, that what is nearer, and yet subtends no greater angle, must be smaller. In viewing these pictures with the stereoscope the effect is quite different, for then convergency is effected at almost the same distance from the eye of the observer as the pictures themselves are placed; there is nothing, therefore, to indicate diminished distance, and consequently no impression of decreased dimensions in the resultant image.

It is owing to this inversion of perspectives that we are obliged to divide the stereoscopic photographs taken by a binocular camera, and reverse their position, in order to produce a proper effect when placed in the stereoscope, and not as has been stated, because we have reversed the pictures in placing the undivided images erect. This certainly puts the right hand picture on the left hand side, but in no degree disturbs the relative distances of similar points, upon which the result wholly depends.

It is an easy problem to place the images in an erect position in the camera, by first receiving them upon a mirror and reflecting them thence upon the ground glass. But this process, although it places the images erect, or rather enables us to view them ourselves in an inverted position, effects no change in the perspectives, and consequently upon application of the stereoscope the illusion of distances remains unchanged.

If, however, we wish to witness the effect of reversing the perspectives in reality at the same time that we place the images in their natural erect position, we have only to place behind each of the object glasses of our camera another lens at a distance greater than the sum of the principal foci of both, (*i.e.* the object and the auxiliary lens,) and permit the landscape to be refracted by both of these lenses upon the ground glass. This arrangement will, of course, have the effect of separately reinverting the images, and will place them in their natural position upon the ground glass, their perspectives perfect, and upon application of the stereoscope we shall perceive a living picture of the landscape before us.

We now come to the beautiful and ingenious discovery of Mr. Claudet.

The writer in adjusting the focus of objects on the ground glass of the camera obscura, had often been struck with the impossibility of obtaining a satisfactory view of the image except from certain angles of observation, and was, therefore, particularly pleased with Mr. Claudet's investigations in elucidation of the mystery.

Mr. Claudet's discovery was announced to the Royal Society in June, 1857, and a notice of it subsequently, July, 1858, copied into this Journal. The author says, "that having observed that the image on the ground glass of the camera obscura appeared as much in relief as the natural objects themselves when seen with two eyes; that his experiments and researches as to the cause, have disclosed the singular fact that though only one image seems depicted thereon, two really exist, one visible only to the right eye and the other only to the left. That the image seen by the former is refracted by the left side of the lens, and that seen by the latter by the right side of the lens. Consequently that these two images presenting two different perspectives, the result is the same as when two different perspectives are viewed with the stereoscope. That all the different images refracted by every part of the lens are each only visible on the line of their refraction when it corresponds with the optic axes."

Mr. Claudet further remarks that if the image be received upon transparent paper instead of ground glass, the illusion of relief is not in the least presented, that all the images refracted from all parts of the lens coincide upon the paper and are visible at whatever angle they are examined. The reason of this difference being that the rays refracted by the lens continue their course in straight lines through the transparent molecules of the ground glass, and are seen only when they coincide with the optic axes; while the paper being perfectly opaque stops all the rays, and becoming itself luminous sends new rays in all directions.

In elucidation of this new principle of ground glass images, Mr. Claudet proposes a number of experiments made with different colored glasses placed before marginal openings of the lens, &c.; and having convinced himself of its correctness, suggests the possibility of a stereoscope being constructed upon this new principle, in which the eyes looking upon a single image could see it in perfect relief. This single image being composed of two images superposed, one visible only to the right eye and the other only to the left.

In a subsequent paper read before the Royal Society in April, 1858, Mr. Claudet states, "that he had succeeded in constructing a stereoscope upon this new principle, to which he had given the name of stereomonoscope, in allusion to its power of producing the stereoscopic effect with apparently but one image."

In pursuance of this interesting subject, the writer has repeated the experiments suggested by Mr. Claudet, some with perfect, all with partial success.

It is not strictly true that, "when looking at the image on the ground glass of a camera obscura, the right eye sees only that refracted by the left side of the lens, and the left eye only that refracted by the right side;" for when the entire lens is exposed, the rays passing through its centre are so slightly converged that each eye receives a portion from both sides of it. The perspectives are thus mingled and the stereoscopic effect greatly impaired.

This is particularly observable when the rays entering the right and left sides of the lens are passed through different colored glasses. A mingling of colors in the centre will be perceptible to either eye to nearly the same extent as when both are used simultaneously.

In conducting these experiments, therefore, it is desirable to exclude the central rays. This is most effectually accomplished by covering the entire face of the lens, and then making marginal apertures at the extremities of its transverse axis. If the lens used has a diameter of four or five inches with marginal apertures of not more than one or one and a half inches, into which are introduced tubes about six inches long, so as to exclude all rays which will not reach the ground glass but may fall upon other parts of the camera—it will then be in a condition to produce the most striking effect.

The contraction of the marginal apertures not only enhances the effect by the exclusion of unnecessary light, but likewise diminishes spherical aberration by reducing the surface of the lens exposed, and proportionally improves the definition of the image; while the inequality of focal distance of differently distant objects and consequent varying convergency of the refracted rays remains unimpaired. The divergency of rays incident upon the lens being by this arrangement at a maximum.

The result is quite different when rays are admitted through an equal aperture in the centre of the lens; for then all rays from near as well as distant points enter it with nearly the same degree of parallelism, and are consequently refracted to points at nearly the same distance behind the lens, and with nearly the same degree of convergency.

If, with the camera arranged as above described, a piece of blue glass be placed before the right hand aperture of the lens, and a piece of yellow glass before the left, the eyes placed equally distant from the centre of the ground glass, will perceive thereon a union or mingling of both these colors. When viewed, however, with the right and left eye alternately within a certain radius, the yellow ray will alone be perceptible to the right eye and the blue ray only to the left.

If the colored glasses be now removed and the camera turned to the landscape, an effect of relief almost magical will be presented. Supposing the camera to be adjusted to the focus of the nearest visible objects; then, by fixing the eyes steadily upon their images and gradually moving the ground glass in towards the lens until middle and greater distances become distinctly delineated, these images of near objects upon which the eyes are fixed, instead of receding with the ground glass, will remain in their original places, *i.e.* at their respective points of convergency, until they appear to stand out several inches in advance of the rest of the picture; while images of more distant objects not perfectly in focus on the ground glass will appear to be placed equally distant behind it. Upon observing one of these boldly advanced images with both eyes placed directly opposite to it, and then by alternately closing them, it will be seen that this image has a lateral motion with regard to other objects depicted on the ground glass, just as was observed in viewing the objects themselves by ordinary vision or their photographic representatives with the stereoscope. If the left eye be closed and the head moved slowly in that direction, a faint duplicate image will become visible to the right of the one in question, growing gradually brighter as the motion is continued, the place of which the original image immediately assumes when the right eye is closed and the left opened, but one image again being visible.

With the right eye closed and the head moved to the right, a left hand duplicate image becomes visible, the place of which the right hand one assumes upon again reversing the eyes.

In both these cases, the distinct image is seen by virtue of rays admitted through the opposite aperture to the eye that receives them, and with the axis of which they are brought to coincide. The faint image being the result of rays passing through the other aperture, not distinctly seen until the axis of this eye is in turn brought to coincide with them. The binocular image in front of the ground glass is seen at the point of convergency to which these two images are approaching.

These striking effects, which we have with so much pleasure observed, will entirely vanish by changing the marginal apertures of our camera from a horizontal to a vertical position. By this arrangement we have reduced our lens to an equivalent with a central aperture equal in diameter with the marginal ones; and although objects are seen by rays transmitted through precisely the same apertures as before, we have exchanged lateral for vertical convergency, and this latter does not avail us in the estimation of distances, producing no corresponding convergency of the optic axes.

If, with the apertures restored to their original horizontal position, transparent paper be substituted for ground glass for the reception of the image, the effect will be modified inversely to the degree of transparency to which the paper is reduced, but not, as Mr. Claudet asserts, entirely destroyed.

The mingling of perspectives will be much more conspicuous, each having a greatly increased range of visibility, so that much greater deviation from the line of refraction is requisite to render the images of either aperture invisible. For the same reason, the paper presenting so much greater obstruction to the transmission of the rays of light—no image is visible at the point of convergency of these rays if at all distant from its surface. No other principle appears to exist in transparent paper effecting this result—as Mr. Claudet insinuates when he says that "paper (*i.e.* transparent paper) being perfectly opaque stops all rays on their passage, by which the image remains fixed on its surface"—except the degree of its transparency. Transparency being that property of a medium which presents no obstruction to the rays of light, and which permits rays refracted on its surface to be seen only in the direct line of their refraction, producing no illumination of the surface at the point of contact visible in other directions; partial transparency, however, admits of partial transmission of the rays of light, rendering objects refracted upon a medium possessing it visible not only in the direct line of refraction but in other directions, in inverse ratio to the degree of its transparency, the surface becoming luminous at the point of contact of the incident ray.

To this latter class belong ground glass, transparent paper, so called, &c.

In confirmation of the similarity of these two media with regard to the transmission of light, notwithstanding Mr. Claudet's assertions to the contrary, the writer has observed that when a double thickness of ground glass or a piece coarsely ground is used, the effects peculiar to transparent media are impaired to almost the same extent as when prepared paper is substituted. On the contrary, when prepared paper is used as a medium, all these effects will be preserved in proportion to the degree of its transparency. This should evidently not be the case if "ground glass were perfectly transparent," or if "paper were wholly opaque."

All these experiments tend to establish the possibility of rays of light rendering themselves visible in other directions than the line of refraction when received upon a ground glass; and if further proof were required it would be found in the improved field of the camera when constructed with a combination of lenses, obtained by the introduction of a second ground glass at the focus of the anterior lens. This conclusively proves that more rays now reach the original ground glass in formation of the ultimate image, than reached it before the introduction of the second ground glass, and consequently that the image of the anterior lens is seen through the instrumentality of this second ground glass in other directions than the direct line of refraction of the rays that form it.

The success of these experiments, therefore, greatly depends upon the degree of transparency of the medium used for the reception of the image; and after procuring the finest ground glass for the purpose, the writer has found the best effect produced by slightly oiling its ground surface, a much greater degree of transparency being thus acquired. Under these circumstances the mingling of perspectives is at a minimum, and the least resistance offered to the projected ray. Every object is seen at its proper focal point instead of on the surface of the ground glass, the rays either before or after convergency passing through it unobstructed. Those objects only are now visible on the ground glass which properly belong there, together with the most distant objects of the landscape, whose ray is too feeble to make its way through in a clearly defined image visible at its point of convergency.

Mr. Claudet is not definite as to the manner in which this convergency is produced; whether mechanically by coincidence of similar points of dissimilar perspectives, as in the stereoscope, or naturally by consecutive concentration of the optic axes upon the various points of the image. In the case under consideration, it is evidently in a degree mechanical, inasmuch as it is instituted by the refractive power of the lens exercised upon the rays issuing from the several points of the object and crossing at their focal point, effecting a corresponding degree of convergency of the optic axes when coincident with them. The image nevertheless is seen as in natural vision without the intervention of further mechanical agency.

The writer having passed through these initiatory steps, has further benefited by the suggestions of Mr. Claudet, and constructed the instrument to which the inventor has given the name of Stereomonoscope.

This instrument much resembles both in construction and appearance an elongated camera obscura, the object to be represented on the ground glass being a stereoscopic plate. The lens of the camera is divided into two semi-lenses, one of which has a rotary as well as lateral motion, in order that the images of the plate may be perfectly superposed.

When properly adjusted the resultant image on the ground glass will be seen in perfect stereoscopic relief.

The success of this instrument is entirely dependent upon the principles investigated in the foregoing article.

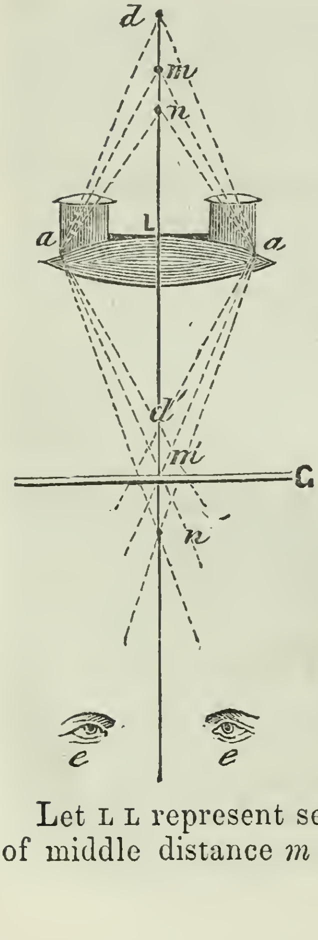
Mr. Claudet naturally supposed that if by refraction of the lens of a camera obscura, two images of an object were so combined upon the ground glass as to produce the stereoscopic illusion, so two separate perspectives of an object might, by the same means, be combined and result in producing a similar effect.

Experiment verified the sagacity of the inference.

The construction and operation of the camera used in the foregoing experiments as well as of the instrument now under consideration, may be better understood by reference to the figures below.

Let *n m d* (Fig. 4) represent near, middle, and distant points of a landscape, and suppose rays issuing from these three points to pass through the marginal apertures *a a* of the lens L of a camera obscura, the remainder of the lens being covered. And let the ground glass G be so adjusted that rays from the middle distance *m* be refracted to a focus precisely upon its surface. It is evident that the more divergent rays from the near point *n* will be more distantly converged at a point *n′* in advance of the ground glass G; while the less divergent rays from the distant point *d* will be converged at a point *d′* behind the ground glass; that these rays, all possessed of different degrees of convergency, will pursue their course, and meeting the eyes at *e e*, will effect a corresponding degree of convergency of the optic axes when coincident with them. The points *n m d* will thus be represented in relief at *n′ m′ d′* respectively.

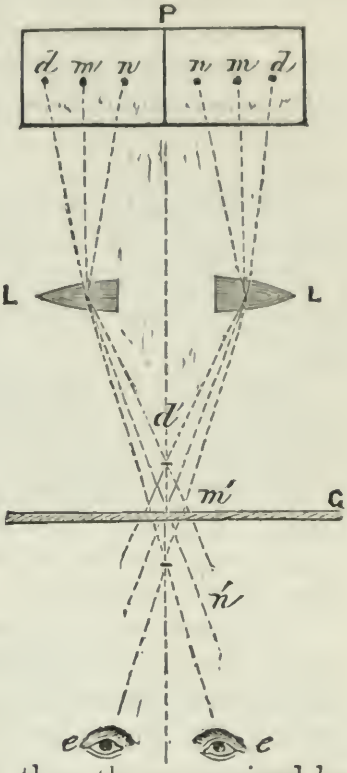
Fig. 4.



Now, let *n m d*, *n m d* (Fig. 5) represent projections of dissimilar perspectives of these same points upon the surface of the stereoscopic plate P.

Let L L represent semi-lenses so separated that rays from the points of middle distance *m m* shall be precisely superposed on the ground glass G placed at the focus of the semi-lenses. It is evident that rays from the points n n, representing a near point of the landscape and consequently more nearly approached in the perspectives, will fall upon the lenses L L with a greater degree of divergency, and will, consequently, be converged at a more distant point n' in advance of the ground glass; while rays from d d representing a distant point of the landscape and already possessed of a degree of convergency will be converged at a near point d' behind the ground glass; and that all these rays possessed of different degrees of convergency will, as in the previous case, by instituting a corresponding degree of convergency of the optic axes, be seen in relief at the points n' m' d' respectively.

Fig. 5.



It may be objected that in these figures rays issuing from the distant points d are after refraction, possessed of a greater degree of convergency than those issuing from near points n. This, however, is only an imperfection in the diagrams, submitted to in order to avoid confusion with lines crossing one another. It is evident that the rays converged at d' as seen in the figures could never reach the eyes as there placed, and that rays converged at that point could meet them only when transmitted through a more central part of the lenses; and further, that the principle upon which the figures are constructed insures by the eyes the reception of no rays from distant points possessed of a greater degree of convergency than those received by them from near points.

In enumerating the advantages of the stereomonoscope over the ordinary lenticular stereoscope, it is suggested that a considerably enarged image may be thrown upon the ground glass, and that this may be subsequently still further increased by viewing it with a large convex lens.

It is undoubtedly true that the stereoscopic image may be somewhat magnified by the semi-lenses by which it is formed, but certainly not without limit.

It must be remembered that we cannot magnify the images of which t is composed without at the same time magnifying their differences of perspective, and this by increasing the distance between their respective points of convergency, renders that process much more difficult for the eyes to effect. Yet another consequence of this amplification would be to create an appreciable difference between the point of superposition of any two similar points of the perspectives and the focal point of the rays issuing from said points, thus interfering with the distinctness of the resultant image. Add to these objections the diffusion of light entailed by the process and its consequent enfeebled transmission through the ground glass, and it will readily be understood that there is a most decided barrier to this species of improvement.

With regard to subsequent magnifying of the image by means of convex lenses, a difficulty will also be found; for in this way we likewise exaggerate the coarseness of the surface upon which it is projected. It must, therefore, be admitted that no very great advantages are to be anticipated from amplification.

Neither, as has been insinuated, can the image be satisfactorily seen from a variety of points of view, for in passing the eyes over it slowly it will be observed that instantly as the converging ray from any point is lost to either eye, will that point of the picture lose its relief and recede to the surface of the ground glass.

In convenience and portability likewise does this instrument in no degree approach its rival the stereoscope.

The very exigences of the principle to be developed are antagonistic to the exercise of any great degree of economy of space in its construction.

That made by the writer is furnished with semi-lenses seven inches in focal length. To produce an image equally large with the object, it is necessary that the latter be placed double the focal length in front of the lenses; the image will then be formed an equal distance behind them. We have thus an instrument twenty-eight inches in length, which must further be carefully inclosed so as to exclude all light not directly instrumental in the formation of the image.

We therefore see that in point of convenience or in perfection of result, the stereomonoscope possesses no advantages over the lenticular stereoscope, and is not likely "to produce a revolution in the application of that splendid discovery to the exhibition of photographic pictures."

This, however, in no degree detracts from the credit due its inventor, for as an instrument illustrative of a new principle in optics and suggestive of solutions to many hitherto unrecorded, if not entirely unobserved phenomena, it is worthy of all admiration and its inventor deserving of all praise.

Germantown, October 7th, 1860.

*The Reaping Machine known to our Celtic Forefathers.**

Truly, there is "nothing new under the sun." A correspondent of the *Gloucester Chronicle* thus writes as to reaping machines:—"It may, perhaps, be interesting to you and to your readers to learn that those 'utter barbarians,' as our British ancestors have been wont to be called, were before us in many of the inventions which are supposed to be the result of modern ingenuity. I am not prepared to say that they had the steam plough, but that they had reaping machines there can be no doubt in the minds of those who read the following much-overlooked passage of Pliny, who wrote between the years 60 and 70 of the Christian era:—

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*From the London Engineer, No. 241.

De Messe et Tritico.

Messis ipsius ratio varia, Galliarum latifundiis, valli prægrandes dentibus in margine infestis duabus rotis per segetem impelluntur, jumento in contrario juncto, ita direptæ in vallum cadunt spicæ.

Of reaping itself there are various methods; in the broad plains of the Gauls, enormous machines with teeth set in a row, placed on two wheels, are driven through the standing corn, a horse being attached to it in a contrary way to the usual mode of attaching horses. Thus the corn, being cut off, falls into the furrow.—*Pliny's Natural History*, *Book* 18, *chap.* 30.

Some question may arise whether we should translate *vallum* as it occurs in the latter part of this sentence differently from the sense given that word at the beginning, *vallus* being a van or machine (see Ainsworth's Dictionary), and *vallum* being a trench or furrow. If we adopt the latter translation, then it follows that our ancestors had already attained that excellence in their machine which was with such difficulty effected in those of modern construction. If, on the other hand, we translate it as the machine itself, then they had accomplished that which our modern inventors have not yet succeeded in, for they must have made the machine not only to reap, but to carry away the corn."

For the Journal of the Franklin Institute.

Strength of Materials: Deduced from the latest experiments of Barlow, Buchanan, Fairbairn, Hodgkinson, Stephenson, Major Wade, U. S. Ordnance Corps, and others. By Chas. H. Haswell, Civil and Marine Engineer.

No. 1.

Elasticity and Strength.

The component parts of a rigid body adhere to each other with a force which is termed *Cohesion*.

Elasticity is the resistance which a body opposes to a change of form.

Strength is the resistance which a body opposes to a permanent separation of its parts.

Elasticity and *Strength*, according to the manner in which a force is exerted upon a body, are distinguished as

1st.—*Tensile Strength*, or Absolute resistance.
2d. —*Transverse Strength*, or resistance to Flexure.
3d. —*Crushing Strength*, or resistance to Compression.
4th.—*Torsional Strength*, or resistance to Torsion.
5th.—*Detrusive Strength*, or resistance to Shearing.

Modulus of Elasticity.

The *Modulus* or *Co-efficient of the Elasticity* of any substance, is a column of the same substance, capable of producing a pressure on its base, which is to the weight causing a certain degree of compression, as the length of the substance is to the diminution of its length; or it is the measure of the elastic reaction or force of any substance.

To ascertain the Extension or Compression in the Length or Height of a Body.

$\text{Q}\,l = \text{E}$. Q *representing the quantity a prism of any substance one inch square and a foot in length, would be extended or diminished by a force or weight* f; *and* l *any other length of a prism of like section and substance.*

To ascertain the Modulus of Elasticity.

Rule.—As the extension or compression of the length of any substance is to its length, so is the weight that produced that extension or compression to the result required.

Or, $\frac{f}{\text{Q}} = \text{M}$; M *representing the weight of the modulus in pounds, for a section or base one inch square.*

If W is the weight of the prism of one inch square and one foot in length,

Then $\frac{f}{\text{W Q}} = \text{H}$; H *representing the height of the modulus of elasticity in feet.*

To ascertain the weight which a given column, nearly perpendicular, is capable of supporting, omitting the effect of the weight of the column itself:

$\cdot 8225\ \frac{d^2}{l^2}\,\text{H} = \text{W}$; d *representing the side of the column.*

Illustration.—A column of pine, assuming the height of its modulus to be 9,000,000 feet, one inch square, and 5 feet in length, may begin to bend with the weight of a like column, equal in length to

$$\cdot 8225 \times \frac{1^2}{(5 \times 12)^2} \times 9{,}000{,}000 = 2056\ \textit{feet},$$

or, with a weight of ($2056 \times \cdot 02 \times 12$, *the product of the length and the weight of* 12 *inches*) 493·44 lbs., *omitting the weight of the column itself.*

The Weight of the Modulus of Elasticity of a horizontal bar fixed at one end, is to a weight suspended from its extremity, as four times the cube of the length, to the product of the square of the depth and the depression.

The Height of the Modulus of Elasticity of a bar, supported at both ends, is ·156 of the fourth power of its length, divided by the product of the depression and the square of the depth.

The weight under which a vertical column or bar not fixed at its base may begin to bend, is to a weight laid on the middle of the same bar, when supported at its ends in a horizontal position, nearly in the ratio of ·002 of the length to the depression.

Modulus of Height of Elasticity of various substances, and the portion of it, which, if applied lengthwise to them, would pull them asunder.

SUBSTANCES.	Feet.	Height of the prism which would be severed by its own weight.	Proportion of height of cohesion to elasticity.
Ash,	4,617,000	42,080	109 th
Beech,	4,180,000	38,910	107
Brass,—Yellow	4,940,000	5,180	954
Brick,		970 144	
Cane,	1,400,000		
Cork,	3,300		
Copper,—Cast		5,000	
Deal,	8,118,000	55,500	146
Elm,	5,680,000	39,050	146
Fir,	8,292,000	40,500	205
Glass,	4,440,000		
Gun Metal,	2,790,000		
Hempen Fibres,	5,000,000		
" Twine,		75,000	
Iron,—Cast	5,750,000	6,110	941
" Wrought, Swedish,	9,000,000	19,740	456
" " English,	7,550,000	16,938	446
Ice,	6,000,000	300	20,000
Limestone,	2,400,000		
"	1,600,000		
"	625,000		
Lignum Vitæ,	1,850,000		
Larch,	5,096,000	42,160	121
Lance Wood,	5,100,000		
Lead,—Cast		348	
Mahogany,	7,500,000		
Marble,—White	2,150,000	1,542	1394
Oak,	4,150,000	32,900	144
Rosewood,	3,600,000		
Slate,	7,800,000	7,300	1068
Steel,—Cast	9,300,000	39,455	235
Stone,—Portland	1,570,000	945	1789
Tanned Cow's Skin,		10,250	
Teak,	6,040,000	36,049	168
Tin,—Cast		1,496	
Whalebone,	1,000,000	14,000	71
Willow,	6,200,000		
Writing Paper,		8,000	
Yellow Pine,	9,150,000		
"	11,840,000		

Modulus of Weight of Elasticity of various substances.

SUBSTANCES.	Weight in lbs.	SUBSTANCES.	Weight in lbs.
Ash, . .	1,525,000	Cast Iron, .	13,000,000 17,000,000
Oak, . .	1,713,600		
Oak,—American .	1,958,700		
Yellow Pine, .	1,856,400	Steel Wire, .	29,500,000
Pitch Pine, .	1,252,000	Steel Plates, .	42,600,000
Red Pine, .	2,142,000	Spruce, .	1,244,000
Bar Iron, . .	28,400,000	Zinc, . .	13,680,000
Wire, .	28,081,000	Brass, .	8,930,000
Beech, . .	1,316,000	Lead, . .	720,000
Mahogany,—Spanish	1,255,000	Gun Metal, .	9,873,000

Tensile Strength.

Tensile Strength is the resistance of the fibres or particles of a body to separation. It is therefore proportional to the number of fibres or particles in the body, or to the area of its transverse section.

The *Absolute Strength* of materials, pulled lengthwise, is in proportion to the squares of their diameters.

TABLE OF THE TENSILE STRENGTH OF MATERIALS.

Power required to tear asunder one Square Inch, in Avoirdupois pounds.

METALS.	lbs.		lbs.
Copper, Wrought .	34,000	Iron, Plates, boiler .	51,000
Cast, American	24,250	“ lengthwise	53,800
Wire .	61,200	“ crosswise	48,800
Bolt .	36,800	“ ship .	44,000
Gold, Cast .	20,000	“ lengthwise	47,600
Iron, Cast, Low Moor	14,076	“ crosswise	40,600
Clyde, No. 1 .	16,125	Inferior bar .	30,000
“ 3	23,468	Lead, Cast .	1,800
Calder, No. 1 .	13,735	Milled .	3,320
Stirling, mean	25,764	Wire .	2,580
Mean of American, by		Platinum, Wire .	53,000
Major Wade,	31,829	Silver, Cast .	40,000
Greenwood, American	45,970	Steel, Cast, maximum	142,000
Gun metal, mean .	30,232	Blistered soft	133,000
Wire .	103,000		104,000
Best bar, Swedish	72,000	Shear .	118,000
Russian bar .	59,500	Blister .	104,000
English bar .	56,000	Spring .	72,500
Rivets, American	53,300	Puddled .	67,200
Mean by Telford .	65,520	Plates, lengthwise	96,300
“ Brunel	68,992	“ crosswise	73,700
“ Barlow .	56,560	Razor .	150,000
English rivets	65,000	Tin, Cast block .	5,000
Crank shaft .	44,750	Banca .	2,122
Turnings .	55,800	Zinc, Cast .	3,500
Scrap .	53,400	Sheet .	16,000

WOODS.

	lbs.		lbs.
Ash,	12,000	Oak, American white	11,500
	16,000	English	10,000
Beech,	11,500	Seasoned	13,600
Box,	20,000	Riga	12,000
Bay,	14,000	African	14,500
Cedar,	11,400	Pine, Pitch (Fir),	12,000
Chestnut, Sweet	10,500	Norway	13,000
Cypress,	6,000	American White	11,800
Deal, Christiana	12,400	Poplar,	7,000
Elm,	13,400	Quince,	6,000
Lance Wood,	23,000	Sycamore,	13,000
Lignum Vitæ,	11,800	Teak, Java	14,000
Locust,	20,500	African	17,000
Mahogany,	21,000	Walnut,	7,800
Spanish	12,000	Willow,	13,000
Maple,	10,500		

COMPOSITIONS.

	lbs.		lbs.
Gold 5, Copper 1,	50,000	Copper 8, Tin 1, small bars,	50,000
Brass,	42,000	Yellow metal,	48,000
" Yellow	18,000	Silver 5, Copper 1,	48,000
Bronze, least	17,698	" 4, Tin 1,	41,000
" greatest	56,788	Tin 10, Antimony 1,	11,000
Copper 10, Tin 1,	32,000	" 10, Zinc 1,	12,914
" 9, " 1,	17,250	" 10, Lead 1,	6,800
" 8, " 1, gun metal,	30,000		

MISCELLANEOUS SUBSTANCES.

	lbs.		lbs.
Brick, well burned	750	Rope, Manilla	3200
inferior	290	Wire	37,000
Chalk,	118	Hemp	6400
Cement, Portland, 6 mos.	414	Mortar, 20 years,	52
" " 7 "	400	Plaster of Paris,	72
Glass, Plate	9400	Slate,	12,000
Flint	4200	Sandstone, Fine grain	200
Green	4800	Stone, Portland	857
Crown	6000		1000
Hemp Fibres,	6400	Hailes	360
glued together,	9200	Craigleith	400
twisted, ¼ to 1 in. dia.	8746	Bath,	352
1 to 3 "	6800	Cement, Sheppy	24
3 to 5 "	5345	Harwich	30
5 to 7 "	4860	Chalk 4, Blue clay 5	70
Ivory,	16,000	Portland 1, Sand 3	380
Marble, White	9000	Whalebone,	7600
Italian	5200		

Hemp ropes, 1 ton per ℔. weight, per fathom.
Wire ropes, 2 tons per ℔. weight, per fathom.

Cast iron (Greenwood) at three successive meltings, gave tenacities of 21,300, 30,100, and 35,700 lbs.

Bronze (gun metal) varies in tenacity from 23,000 to 54,500 lbs.

The fibres of woods are strongest near the centre of the trunk or limb of the tree.

Experiments on cast iron bars give a tensile strength of from 4000 lbs. to 5000 lbs. per square inch of its section, as just sufficient to balance the elasticity of the metal; and as a bar of it is extended one five thousand five hundredth part of its length for every ton of direct strain per square inch of its section, it is deduced that its elasticity is fully excited when it is extended less than the three thousandth part of its length.

The mean tensile strength, then, of cast iron being from 16,000lbs. to 20,000 lbs., the *Value* of it, when subjected to a tensile strain, may be safely estimated at from one-fourth to one-third of this, or of its breaking strain.

A bar of cast iron will contract or expand ·000006173, or the 162,000ths of its length for each degree of heat; and assuming the extreme range of the temperature in this country, between the shade in winter and the sun's rays in summer, in the Middle States, to be 140° (—20° + 120°), it will contract or expand with this change ·0008542, or the 1157ths of its length.

It follows, then, that as 2240 lbs. will extend a bar the 5500th part of its length, the contraction or extension for the 1157th part, will be equivalent to a force of 10,645ths (4·75 tons) per square inch of section.

Experiments on wrought iron bars give a tensile strength of from 18,000 lbs. to 22,400 lbs. (10 tons) per square inch of its section, as just sufficient to balance the elasticity of the metal; and as a bar of it is extended the ten-thousandth part of its length for every ton of direct strain per square inch of its section, it is deduced that its elasticity is fully excited when it is extended the one-thousandth part of its length.

The mean tensile strength, then, of wrought iron being from 55,000 lbs. to 65,000 lbs., the *Value* of it, when subjected to a tensile strain, may be safely estimated at from three-tenths to one-fourth of this, or of its breaking strain.

A bar of wrought iron will expand or contract ·000006614, or the 151,200th part of its length for each degree of heat; and assuming, as before stated for cast iron, that the extreme range of temperature in the air in this country is 140°, it will contract or expand with this change, with a force equivalent to 20,740 lbs. (9·25 tons) per square inch of section.

The tensile force of metals varies with their temperature, generally decreasing as the temperature is increased.

In silver, the tenacity decreases more rapidly than the temperature; in copper, gold, platinum, and palladium, it decreases less rapidly than the temperature.

In iron, the tenacity is less at 212° than at 32°, and at 392° it is greater than at 32°.

Tensile strength of the strongest piece of cast iron ever tested,—45,970 lbs. This was a mixture of grades 1, 2 and 3 of Greenwood ron, and at the 3d fusion.

Adhesion of Roman cement to blue stone, 77 lbs. per square inch.

Table of Elements connected with the Tensile Resistance of various substances.

SUBSTANCES.	Tensile Strain per square inch for limit of elasticity.	Proportional elongation for strain of limit of elasticity.	Ratio of strain in column 1 to that causing rupture.
	lbs.		
Oak, . . .	2,856	·00167	·23
Yellow Pine, . .	3,332	·00117	·33
Beech, . . .	3,355	·00212	·30
Wrought Iron, ordinary .	17,600	·00062	·30
Swedish .	24,400	·00093	·44
English .	18,850	·00072	·37
	22,400	·00086	·44
American .	21,000	·00080	·40
do. Wire, No. 9, unannealed	47,532	·00165	·49
annealed	36,300	·00129	·58
Steel Plates, blue tempered	93,720	·00222	·67
Wire, . .	35.700	·00120	·50
Cast Iron, English .	4,000	·00116	·25
American .	5,000	·00149	·25

(To be Continued.)

For the Journal of the Franklin Institute.

Particulars of the Steam Ferry Boat John P. Jackson.

Hull built by O. Burtis, Brooklyn, N. Y. Machinery by William Birkbeck, Jersey City, N. J. Owners, New Jersey Transportation Company.

HULL.—Length on deck, 210 ft. Do. at load line, 210 ft. Breadth of beam (molded), 33 ft. Depth of hold, 13 feet. Do., to spar deck, 13 feet. Frames—molded, 14 ins.—sided, 6 ins.—apart at centres, 12 ins. Keel, depth, 11. Draft of water, forward and aft, 5 feet 6 inches. Tonnage, 858. Area of immersed section at load draft of 5 feet, 140 sq. feet.

ENGINES.—Vertical beam. Diameter of cylinder, 45 ins. Length of stroke, 11 feet. Cut-off at one-third.

BOILER.—One—Drop flue, round shell. Length of boiler, 30 feet. Breadth of do., 10 feet. Height do., exclusive of steam chimney, 10 feet. Number of furnaces, two. Length of grate bars, 6 ft. Number of flues, above, 6 of 15½ ins.; in centre, 6 of 15 ins.; below, 2 of 23 ins., 2 of 14 ins. Length of flues, above, 18 ft.; in centre, 15 ft. 10 ins.; below, 17 ft. 10 ins. Diameter of smoke pipe, 4 ft. 6 ins. Height do., 48 ft.

PADDLE WHEELS.—Diameter over boards, 21 feet. Length of blades, 9 feet. Depth do., two of 12 ins. Number do., 18.

Remarks.—This is the largest ferry boat ever built in this section of the country, and is to ply between the City of New York and Jersey City. Date of trial, October, 1860. C. H. H.

For the Journal of the Franklin Institute.

Particulars of the Steamer John P. King.

Hull built by J. A. Westervelt & Sons. Machinery by Allaire Works, New York. Owners, Spofford, Tileston & Co.

HULL.—Length on deck, 235 ft. Do. at load line, 233 ft. Breadth of beam (molded), 36 ft. 4 ins. Depth of hold, 13 ft. 3 ins. Do., to spar deck, 20 feet. 9 ins. Frames—molded, 15 ins.—sided, 14 ins.—apart from centres, 30 ins. Keel, depth 11. Draft of water, forward and aft, 12 ft. Tonnage, 1740. Area of immersed section at load draft of 12 ft., 371 sq. ft. Masts, two.—Rig, schooner.

ENGINES.—Vertical beam. Diameter of cylinder, 71 ins. Length of stroke, 12 feet. Maximum pressure of steam, 30 lbs. Cut-off—variable.

BOILERS.—Two—Return flue. Length of boilers, 26 ft. Breadth of do., 12 ft. 2 ins. Height do., exclusive of steam chimney, 12 ft. 2 ins. Number of furnaces, 5 in each. Breadth do., 3 ft. $\frac{1}{2}$ in. Length of grate bars, 7 ft. 3 ins. Number of flues, above, 18, below, 15. Internal diameter of flues, above, 8 of 13 ins., 8 of 11 ins., 2 of 10 ins.; below, 15 inches. Length of flues, above, 19 ft. 4 ins., below, 12 ft. 7 ins. Grate surface, 225 sq. ft. Heating surface, 5426 sq. feet. Diameter of smoke pipes, 7 feet. Height of do., 60 feet.

PADDLE WHEELS.—Diameter over boards, 28 feet. Length of blades, 10 feet. Depth do., 12 ins. Number do., 24.

Date of trial, October, 1860. C. H. H.

*Description of Fryer's Apparatus for Filling Locomotive Tenders with Water.** By Mr. JAMES FENTON, of Low Moor.

Dr. Papin, the celebrated French precursor of the many inventions connected with modern steam power, demonstrated, as early as the year 1700, the practicability of raising water by the direct action of steam pressure on its surface; and this system is still adopted with complete success for raising saccharine fluids in most sugar houses throughout the world. The method of filling locomotive tenders with water, where the supply is below the level of the railway, recently invented by Mr. Alfred Fryer, of Manchester, and forming the subject of the present paper, is, in fact, an adaptation of Dr. Papin's simple contrivance of 160 years ago.

The apparatus consists of a wrought iron cylinder of 1500 or 2000 gallons capacity, placed upright beneath the surface of the supply water, which may be from 10 to 120 feet below the level of the railway. To reduce the amount of condensation, the cylinder is surrounded with brickwork, and a space of 2 inches between the brickwork and the cylinder is filled with clay, to prevent any water from getting to the outside of the cylinder. The cylinder contains a wrought iron float, fitting it easily, and sliding on a centre guide-rod. The supply water enters through a self-acting inlet valve, of about 75 square inches area, at the top of the cylinder, and it is discharged from the bottom of the cylinder through a pipe leading to the engine water-crane. A steam-pipe is attached to the top of the cylinder, leading to two pillars placed a few yards distant on each side of the crane, and near the line of rails, and provided with flexible pipes, having bayonet joints for coupling to the locomotive boiler. When a tender is drawn up to be filled, the engine-driver couples one of the flexible pipes to the boiler, and turns on the steam, which, passing into the water cylinder, presses on the float, and forces the water up through the crane into the tender with great rapidity.

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* From Newton's London Journal, August, 1860.

To prevent the steam now contained in the upper part of the cylinder from blowing out violently into the atmosphere when the flexible pipe is disconnected, a valve is placed in the top of the pillars, opening inwards, which allows a free passage for the steam to enter the cylinder; but when the pipe is uncoupled, the steam can only escape slowly through a small hole drilled in the valve. A hanging valve is placed between the two branches of the steam-pipe, which prevents the steam entering through one of the pillars, from blowing out direct through the other, instead of passing down into the cylinder. As the steam escapes from the cylinder, a fresh supply of water enters it through the inlet valve, the cylinder being placed below the surface of the supply water. This valve is contained within a well, and the supply water is admitted through a valve and grating, by which it can be stopped back out of the well at any time, for the purpose of examining the inlet valve; or the valve itself can be detached and drawn up to the top of the well, being slidden down to its place upon guide-rods, and secured by long screwed bolts that can be reached from the surface. The float is strengthened against collapsing by circular stays; and a small tube is inserted in it, reaching almost to the bottom, so that if any water should get into the interior of the float through a defective joint, it is expelled through the tube as soon as the pressure of steam is removed from the outside of the float, after filling a tender.

The apparatus is equally applicable when the supply of water is obtained from a reservoir at the foot of an embankment, from a well considerably below the level of the ground, or from running water.

In this plan of raising water by the direct action of steam pressure, it might be expected that the condensation of steam in the water cylinder would be so considerable as to interfere seriously with the working of the apparatus; but it must be borne in mind that the larger the cylinder, the smaller is the extent of surface presented for condensation, in proportion to its contents; and it has been proved by experiment that this is not a serious objection in the size of the present apparatus; while the friction and waste of power involved with the pumps and engines now in use are obviously saved. In order to ascertain whether a locomotive boiler can afford to lose the amount of steam requisite to raise the water, especially where the lift is from 50 to 60 feet high, a boiler has been constructed of 141 gallons capacity, 69 per cent. of which was filled with water, connected by a flexible tube with a water cylinder holding 131 gallons,—the arrangement being in all respects similar to that already described; the discharge water pipe from the cylinder rose 60 feet perpendicularly, but had valves at various lower elevations. The water pipe was 4 inches diameter inside, and the steam pipe 1½ inches diameter, and the area of steam way in the tap 1·83 square inches. Many trials were made, in each of which 131 gallons of water were raised; the average height of lift being 52 feet, and the average pressure of steam in the boiler 56½ lbs. per square inch. In order to guard against too rapid a generation of steam, and to approximate to the condition of a locomotive when standing at a station, the damper remained closed during each trial. It was then found that the loss of steam pressure in raising the 131 gallons of water 52 feet high, was only 4·2 lbs. per square inch, and the time required, 32 seconds. When the damper remained open, the steam was generated more rapidly than it was used, and the pressure then rose during each trial. Hence, a locomotive just arrived at a station will always have sufficient steam to spare to refill the tender; and this will consequently be effected at the entire saving of the pumping engines, pumps, and buildings at present necessary, while the heavy expenses now incurred of attendance, repairs, and fuel, are dispensed with.

With this apparatus, there is no difficulty in working during frost; the crane and pipes being kept always empty, and the water cylinder below the ice—thus removing the danger of the pipes bursting, and obviating the necessity of keeping them thawed by the application of fires, as in the case of the present water cranes. This is a consideration of no little importance, especially in Canada and other countries subject to severe and protracted frosts. The steam that is condensed in forcing up the water is not entirely lost, as it serves slightly to warm the water which will shortly supply the boiler. It has been computed that the cost in fuel of raising 1000 gallons of water 50 feet high, by this process, is less than one halfpenny; and the plan is therefore recommended by economy, great simplicity, and rapidity of action.

Mr. A. Fryer said, he had been led to this plan by difficulties experienced in raising continually large quantities of saccharine fluids, of a specific gravity of about 1·3, which had to be raised a height of 60 feet, to the top of the sugar manufactory. Cranes were previously used to lift the bags of rough sugar to the top of the building, but this was found to be a slow and expensive process when a large amount had to be conveyed, and pumps were then employed for the purpose; the first process of dissolving the sugar in hot water being performed at the bottom of the building, and the liquid then pumped up to the top; but the pumps were found to be rapidly worn and cut by the large quantity of sand, pieces of cane, and other rubbish that was nixed with the rough sugar, and no form of pump was able to stand he work. He then tried the direct application of the steam pressure o force up the liquid through a pipe, and found it so completely suc-essful that the plan was adopted for the whole of the work. The lissolved sugar was put in a large close vessel, like a circular boiler, feet diameter, with a delivery pipe 4 inches diameter, extending from it to the top of the building, a height of 60 feet; and steam at 0 lbs. per inch pressure was let into the upper part of the vessel, ind, pressing upon the surface of the liquid, forced it instantly up the lelivery pipe, the lower end of which reached to the bottom of the vessel inside. The process was effected with great rapidity, the solid refuse lying at the bottom of the vessel being swept clean out, together with the liquid. A quantity of 20,000 gallons per day was regularly raised in this way, and the solid matter carried up besides amounted to several tons per day. The vessel was recharged by condensing the steam in it by a jet of cold water upon the outside, and opening a communication with the vat in which the sugar was dissolved; the vessel then became rapidly filled, and the process of letting in the steam and expelling the contents up the delivery pipe was directly repeated. There was found to be but little waste of steam in this process, although no float was used in the vessel, and the steam was admitted direct upon the surface of the liquid; for a film of boiling water was immediately formed upon the surface of the liquid by the condensation of a small portion of the steam, which acted effectually as a non-conducting diaphragm, cutting off the communication with the colder liquid below, since there was no circulation to convey the heat downwards.

He had also made a trial of the same plan for raising water from a well 65 feet deep upon the works, in which the pump was sometimes under water, so that the valves could not be reached for repairs, and the pump was consequently stopped working; and he had succeeded in raising 100,000 gallons of water per day from the well, by that means. In this case, the rising main from the pumps, which was 18 inches diameter, had a second pipe, 4 inches diameter, inserted within it extending nearly to the bottom, and having a valve at the bottom opening upwards; the space between the two pipes was closed at the top with a steam-tight joint, and steam of 40 lbs. pressure was admitted to it from an adjoining boiler. This steam expelled the water from the space between the pipes, driving it up the centre pipe; and on shutting off the steam, a fresh supply of water entered this space by condensation of the steam, and was again expelled up the centre pipe by repeating the process.

In order to ascertain whether, in the case of filling locomotive tenders, there would be any risk of difficulty from want of sufficient steam in the engine boiler to serve for raising the water, he had tried some experiments with a small boiler disconnected from any other work, raising the water by the steam pressure, from a close vessel up a vertical stand-pipe, which had cocks fixed into the side at different levels, that could be opened successively for discharging the water.

He found that the water was discharged at 60 feet height, with a pressure of steam in the boiler of 27 lbs. per square inch, which was only slightly above the pressure required to balance the column of water. The quantity of steam required was found to be so small, that a supply of water sufficient to fill a locomotive tender was easily raised with the boiler fire checked and the damper kept closed, to correspond with the condition of a locomotive standing at a station. In applying this plan for filling tenders, his object was to employ the power available in the locomotive engine for raising the water direct, instead of requiring the erection of fixed pumping machinery and engine power at each station.

It was thought that the plan possessed many advantages. It had great simplicity, and was free from liability to derangement from frost; the saving also in first cost would be very considerable, where stationary engines had now to be employed for pumping.

AMERICAN PATENTS.

AMERICAN PATENTS ISSUED FROM AUGUST 1, TO AUGUST 31, 1860.

Alkalies,—Preservat. of Caustic	John Seiberling,	Philadelphia,	Penna.	14
Amalgamator,	Wm. Gluyas,	San Francisco,	Cal.	7
————	James White,	Bangor,	Me.	28
Ant Trap,	Cottingham & Menefee,	Texana,	Texas,	7
Artificial Legs,	B. W. Jewett,	Gilford,	N. H.	7
Auger,	W. A. Ives,	N. Haven,	Conn.	28
Augers,—Handle Fastenings for	J. M. Hathaway,	City of	N. Y.	21
Bed Bottom,	L. W. Buxton,	Nashua,	N. H.	7
———— Slat,	J. N. Dennett,	Bath,	Me.	21
Bedstead,	Wm. Deckmann,	Canton,	Ohio,	21
————	John Leigh,	Edgefield,	S. C.	7
———— Fastening,	H. T. Smith,	Washington,	D. C.	14
Beehives,	Daniel Arndt,	Zanesville,	Ohio,	21
————	E. S. Bacon,	Albion,	N. Y.	28
————	Wm. Hyde,	Emery,	Ohio,	7
————	Samuel Maitland,	Fort Wayne,	Ind.	28
————	C. Williams,	Weston,	Mo.	28
Bells,—Apparatus for Ringing	James Harrison,	Troy,	N. Y.	28
Belt-shipper,	J. C. Goar,	Monterey,	Cal.	14
Black-boards,—Composition for	J. B. Rowell,	Lynn,	Mass.	7
Blanks,—Machine for Rolling	N. C. Lewis,	Boston,	"	7
Blind Rods,—Wiring	Jacob Coover,	Chambersburg,	Penna.	7
Boiler Tubes,—Drawing	S. J. Perry,	Columbia,	S. C.	21
Books and Paper,—Trimming	Gabriel Utley,	Chapel Hill,	N. C.	7
Boots & Shoes,—Manufacture of	L. R. Blake,	Abington,	Mass.	14
————————	"	"	"	14
Bottles,	J. N. Bodine,	Bridgeton,	N. J.	14
————	John Maurer,	City of	N. Y.	14
————,—Apparatus for Filling	C. A. Gregory,	Poughkeepsie,	"	28
Boxes,—Cutting	C. Sewerkrop,	Louisville,	Ky.	7
Brakes,—Car	H. W. Norvill,	Livingston,	Ala.	21
————,—Carriage	Edward Behr,	City of	N. Y.	7
————,—Railroad Car	Walter Somerville, Jr.,	Mitchell Stat.,	Va.	21
————,—Self-acting Wagon	George Buchanan,	Hickory,	Penna.	28
Bread Slicer,	L. W. Baker,	Marlboro',	Mass.	14
Breast Pumps,—Construction of	J. H. Beadle,	City of	N. Y.	21

Brick Machines,	W. S. Wallace,	Americus,	Ga.	28
————	Wm. Wood,	Hartford,	Conn.	14
Burglar Alarm,—Clock and	G. K. Proctor,	Beverly,	Mass.	7
Butter-worker,	L. S. Ingraham,	Grafton,	Ohio,	7
Candle-wicks,	J. H. Tatum,	City of	N. Y.	21
Candles,—Machinery for Mould.	Ferdinand Meyrose,	St. Louis,	Mo.	7
Cane-coverers,	E. H. Angamar,	New Orleans,	La.	28
Cans,—Exhausting and Sealing	W. Y. Gill,	Henderson,	Ky.	14
——,—Grooves in Necks of	J. D. Willoughby,	Petersburg,	Va.	21
Car Register,	L. H. French,	Philadelphia,	Penna.	28
—— Seats and Couches,	David Pennoyer,	North East,	N. Y.	28
Cars,—Iron	Richard Montgomery,	City of	"	7
——,—Sleeping	J. B. Sutherland,	Detroit,	Mich.	14
Carriages,—Exten. of Seats for	J. A. Naylor,	Rahway,	N. J.	21
Cattle Ties,	George Hull,	Port Crane,	N. Y.	28
Chair Bottom,—Metallic	Volney Stockton,	Williamsburgh,	Ohio,	7
———,—Folding	J. H. Swan,	City of	N. Y.	21
Cheese Cutter,	J. G. Barker,	Watertown,	Mass.	14
——— Hoops,	H. A. Roe,	Madison,	Ohio,	28
Chuck and Counter-sink,	Daniel Argerbright,	Gratis,	"	21
Churn,	J. M. Buell,	Zanesville,	"	7
———	Hutchins & Leach,	Penobscot,	Me.	14
Clothes Dryer,	Ransom Gilbert,	Morrisville,	Vt.	28
————	D. K. Hickok,	"	"	21
————	Josee Johnson,	City of	N. Y.	14
Coal,—Separating Slate from	L. P. Garner,	Ashland Bor'h,	Penna.	7
Coffee Roaster,	R. Little,	Middle Branch,	Ohio,	28
Coloring Matter from Oak Bark,	Carl Henrichs,	City of	N. Y.	7
Cooking Range,	E. G. Niles,	Cincinnati,	Ohio,	21
Cork-drawer,	Chas. Alexander,	Washington,	D. C.	7
Corn Planters,	F. G. and E. A. Floyd,	Macomb,	Ill.	28
————	J. S. Fowler,	Peoria,	"	14
————	Aaron Miller,	Brockport,	N. Y.	14
————	D. and H. Wolf,	Lebanon,	Penna.	28
————	C. L. Waffle,	Sharon,	Ohio,	21
—— Shellers,	George Danforth,	Friendsville,	Ill.	21
—— Stalk Cutters,	J. R. Marshall,	Marine,	"	21
Cotton Bales,—Fastenings for	J. W. Evans,	City of	N. Y.	21
——— Gins,	A. H. Burdine,	Chulahoma,	Miss.	28
————	John Goulding,	N. Wilbraham,	Mass.	28
——— Presses,	J. C. Sellers,	Woodville,	Miss.	28
Couplings for Belts,	Chas. Fairfax, Jr.,	Cincinnati,	Ohio,	21
———,—Car	R. S. Potter,	Chicago,	Ill.	28
————	L. H. Shular,	Crawfordsville,	Ind.	7
Coupling,—Hose	George Hancock,	Providence,	R. I.	7
Couplings,—Railroad Car	W. H. H. Miller,	Williamsport,	Penna.	28
Crimping Machines,	David Bissell,	Detroit,	Mich.	28
Cultivators,	Thomas Black,	Princeville,	Ill.	28
————	Schuyler Goldsmith,	Wataga,	"	14
————	L. E. Hawkins,	Sangamon,	"	14
————	E. S. Huff,	Zanesville,	Ohio,	28
————	Lewis Leber,	Springfield,	Ill.	21
————	T. W. McDill,	Oquawka,	"	21
————	Mark Rigell,	Dawson,	Ga.	14
————	Jackson Shannon,	Dakota,	Wis.	14
————	Taylor & Graves,	Fort Adams,	Miss.	14
————	Ephraim Wells,	Auburn,	"	28
————	Ferdinand Wolf,	Brooklyn,	N. Y.	14
————	G. W. N. Yost,	Yellow Springs,	Ohio,	28
————,—Cotton	J. L. Middlebrooks,	Salem,	Ga.	7
Cupboard and Sink,	Anthoni Iske,	Lancaster,	Penna.	7
Cutlery,—Handles for	Matthew Chapman,	Greenfield,	Mass.	7

Decolorizers,—Compounds as	P. M. Belton,	Brooklyn,	N. Y.	14
Deep Sea Sounding Meter,	J. M. Brooke,		U. S. N.	7
Distillers Mash Tubs,—Constr.	D. P. Patterson,	Fayette co.,	Penna.	21
Ditching Machines,	A. S. Ballard,	Mt. Pleasant,	Iowa,	14
Doors Open,—Holding	Arthur de Witzleben,	Washington,	D. C.	28
Drain Tiles,—Bottom Plates for	John Parsons,	Cleveland,	Ohio,	7
Drain Tile Machines,	Gottlieb Graessle,	Hamilton,	"	14
Drills,—Rock	David Ralston,	Carlisle,	Penna.	21
Elevators for Store-houses,	W. H. Allen,	Brooklyn,	N. Y.	28
Files,—Machines for Cutting	Wm. Van Anden,	Poughkeepsie,	"	14
Fire Arms,—Projectiles for	Cranston & Bates,	New London,	Conn.	14
———,—Rammers for Revol.	C. R. Alsop,	Middletown,	"	7
—— Escape,	O. F. Burton,	City of	N. Y.	7
Flasks for Casting Iron Columns,	Henry Demmick,	"	"	21
Flour,—Device for Bolting,	Wm. Halderman,	Freeport,	Ill.	7
Fodder,—Machine for Cutting	P. S. Clinger,	Conestoga Cen.	Penna.	14
Foot-scrapers,	E. G. Burger,	Ypsilanti,	Mich.	14
Fruit Cans,—Sealing	Cooper & Haller,	Carlisle,	Penna.	7
—— Jars,	J. C. Baker,	Mechanicsburg,	Ohio,	14
Furnaces,	D. T. Woodrow,	Cincinnati,	"	28
———,—Feeding Sawdust to	Samuel Kennedy,	Hibbetts,	"	28
——— for Heating Buildings	W. H. Churchman,	Janesville,	Wis.	14
Gas,—Apparatus for Compress'g	W. H. Gwynne,	City of	N. Y.	7
—— Burners,	A. G. Hamaker,	Peoria,	Ill.	7
—— Meters,	Nathaniel Tufts, Jr.,	Boston,	Mass.	14
———	Wilson & Fox,	Reading,	Penna.	21
—— Pipe-cutter,	Wm. Kenyon,	Steubenville,	Ohio,	14
Gate,	H. A. House,	Brooklyn,	N. Y.	21
——	D. E. Fenn,	Tallmadge,	Ohio,	28
——	Wm. McAfee,	Summerville,	Mich,	21
Gearing,	A. M. Street,	Denmark,	Tenn.	14
Girders,—Trussed Compound	J. A. Roebling,	Trenton,	N. J.	28
Glass Vessels,—Attach. Covers to	R. D. Bryce,	E. Birmingham,	Penna.	21
———————	Reighard & Knecht,	Birmingham,	"	21
———,—Metallic Covers	John Bird,	"	"	21
Globe,—Auto. Terrestrial Time	F. S. Barnard,	City of	N. Y.	28
Glue,—Machines for Cutting	Thomas Brown, Jr.,	S. Danvers,	Mass.	7
——,—Preparation of	J. M. Hunter,	City of	N. Y.	14
Gold Chains,—Making	Isaac Lindsley,	Providence,	R. I.	7
—— Pens,—Rolling	Alexander Morton,	City of	N. Y.	28
—— Washer and Amalgamator	J. C. Dickey,	Saratoga Spr's,	"	28
Grain Separators,	N. A. Patterson,	Kingston,	Tenn.	28
Grinding Grain and Apples,	C. B. Hutchinson,	Auburn,	N. Y.	7
Grubbing Machines,	J. B. Ash,	Elkton,	Md.	21
Guns,—Cane	Armenius Davis,	Shelbyville,	Ind.	21
Hammers,	Reinhold Boeklen,	Brooklyn,	N. Y.	28
Hand-cuff,	Wm H. Kimball,	Augusta,	Me.	7
Harrows,	M. D. Meriwether,	Denmark,	Tenn.	28
Harvesters,	George Farmer,	Osceola,	Fla.	21
———	J. H. Irwin,	Beardstown,	Ill.	21
———	F. H. Manny,	Rockford,	"	28
———	W. S. Stetson,	Baltimore,	Md.	14
———,—Auto. Rakes for	I. C. Twining,	Wrightstown,	Penna.	14
———,—Grain	Chas. Marston,	Viroqua,	Wis.	14
Harvesting Machines,	J. H. Maydole,	Eaton,	N. Y.	7
Hat-bodies,—Forming	Wm. Fuzzard,	Charlestown,	Mass.	7
Heating & Cooking Apparatuses	Edward Conway,	Dayton,	Ohio,	28
——— Rooms,—Device for	Lewis Newsom,	Gallipolis,	"	21
Hinges,—Spike for	Henry Garrett,	Richmond,	Mo.	7
Horse-shoe Nails,—Machine for	Amos Whittemore,	Cambridgeport,	Mass.	14
Horses Hoofs,—Paring	Abraham Baker,	Shenandoah co.,	Va.	7

Insects,—Appa's for Destroying	Adolph Isaacsen,	City of	N. Y.	21
Ink Bottles,—Case for Indelible	Edward Daniels,	Southampton,	Mass.	7
Iron Bars, &c.,—Rolling	Bernard Lauth,	Pittsburgh,	Penna.	21
Joists,—Machine for Dressing	J. H. Story,	Cincinnati,	Ohio,	21
Journal Boxes,	Montgomery Queen,	Brooklyn,	N. Y.	28
Knitting Machines,	Walter Aiken,	Franklin,	N. H.	7
Lamps,	George Blanchard,	City of	N. Y.	7
———	T. B. Smith,	Marietta,	Ohio,	28
———	J. T. Williams,	York Borough,	Penna.	28
Lanterns,	T. B. De Forest,	City of	N. Y.	7
Lathe,	B. D. Whitney,	Winchendon,	Mass.	7
Leather-splitting Machines,	J. F. Flanders,	Boston,	"	14
Life-boat,	Samuel Mills,	City of	N. Y.	7
Lock,	Wm. H. Greenwood,	Galva,	Ill.	14
Locom. Engs.,—Dispos'g Sparks	L. P. Teed,	Wh. Deer Mills,	Penna.	7
———————,—Water-heater	S. F. Allen,	Chicago,	Ill.	7
Lubricator,	E., B., & T. S. Parker,	Schenectady,	N. Y.	7
Manganese,—Manu. of Oxyd for	C. T. Dunlop,	Glasgow,	N. Brit.	7
Marking Stock,—Mode of	John Merry,	Eldorado co.,	Cal.	14
Mattress,—Spring	Herrmann Jury,	City of	N. Y.	14
———————	Whitehead & Kettle,	"	"	28
Meat and Vegetable Chopper,	L. S. Chichester,	"	"	28
Metallic Alloy for Journals,	George Sherman,	Memphis,	Tenn.	7
Military Caps,	J. S. Smith,	City of	N. Y.	21
Mill,—Grinding	Daniel Read,	Hamilton,	"	7
——,—Sugar-grinding	G. J. Rice,	Frederick City,	Md.	14
Mills,—Gig	James Shaw,	Manayunk,	Penna.	28
—— for Cutting and Grinding,	Evariste Mire,	New Orleans,	La.	7
——,—Grinding	P. G. McCulla,	Philadelphia,	Penna.	14
——,—Portable,	Nelson Burr,	Batavia,	Ill.	7
——,—Quartz	J. C. Davis,	San Francisco,	Cal.	7
——,—Sugar Cane,	H. T. Douglas,	Zanesville,	Ohio,	28
Millstones,—Curb for	O. L. Richardson,	Athens,	Ga.	14
————,—Machines for Pick'g	John Kelly,	W. Milton,	Ohio,	21
————,———————— Dress'g	S. K. Landes,	W. Cocalico,	Penna.	21
Molding Machine,—Shaping &	H. D. Stover,	City of	N. Y.	21
Mop-holder,	B. W. Bruel,	Beloit,	Wis.	14
Nail Head,—Picture	J. B. Sargent,	New Britain,	Conn.	21
—— Plate-feeders,	Wm. Riley, Jr.,	Reading,	Penna.	14
Nails,—Cleansing, &c., Galvan.	Wm. Blake,	Boston,	Mass.	21
Omnibus Registers,—Self-lock'g	Michael Offley,	Baltimore,	Md.	7
Ores,—De-oxydizing	Isaac Rogers,	N. Haverstraw,	N. Y.	21
Ovens,	J. M. Read,	Boston,	Mass.	28
Oxychloride of Lead,—Making	Ludwig Brumlen,	Hoboken,	N. J.	21
Paddle Wheels,—Fastening for	Ezra Reid,	Bazetta,	Ohio,	28
Paint Can,	E. A. Leland,	Brooklyn,	N. Y.	14
Paper Pulp,	F. De Compoloro,		France,	7
—— Stock,—Manu. of Leather	E. and J. R. Cushman,	Amherst,	Mass.	21
Pavements, &c.,—Composition	George Scrimshaw,	Milesburg,	Penna.	21
Photographic Camera,	August Semmendinger,	City of	N. Y.	7
———————— Medal,	D. F. Maltby,	Waterbury,	Conn.	14
Piano-forte,	Herman Linderman,	City of	N. Y.	7
———— Keys,	C. J. Schoenemann,	"	"	7
Picture Frames, &c.,—Enamel'g	Robert Marcher,	"	"	14
Pipes,—Cleansing Galvan. Iron	Wm. Blake,	Boston,	Mass.	21
——,—Construc. & Joining of	T. S. Truss,	Darlington,	Engl'd,	21
Planing Machine,	H. D. Stover,	City of	N. Y.	21
————,—Cutter-head for rotary	"	"	"	14
————————————	Theodore Christian,	"	"	28

Ploughs,	J. P. Bond,	Greenwood,	S. C.	14
———	L. D. Burch,	Sherburne,	N. Y.	14
———	Samuel Canterberry,	Holmes co.,	Miss.	14
———	J. S. Hall,	W. Manchester,	Penna.	14
———	"	"	"	14
———	A. Roden,	Talladega,	Ga.	28
———	James Smith,	Norfolk,	Va.	14
———	P. H. Starke,	Richmond,	"	21
———	Bancroft Woodcock,	Williamsburgh,	Penna.	21
———	W. E. Wormell,	Germantown,	Tenn.	28
———,—Adjustable Moles for	Lathrop Kazar,	Leroy,	Ill	14
———,—Hillside	Miller & Henry,	Cincinnati,	Ohio,	21
Post Holes,—Machs. for Digging	A. W. Porter,	St. Johnsville,	N. Y.	7
Presses,	L. W. Harris,	Waterville,	"	28
———	A. Roden,	Talladega,	Ala.	21
Press,—Copying	C. F. Grabo,	Boston,	Mass.	14
———,—Cotton	P. B. Wever,	Scarborough,	Ga.	21
Presses,—Printing	J. E. Briest,	St. Louis,	Mo.	28
———	G. F. Hebard & others,	Buffalo,	N. Y.	7
———	Wells & Barth,	Cincinnati,	Ohio,	7
———	Thomas Hall,	St. Louis,	Mo.	7
Propeller for Canal Boats,	Edward Backus,	Rochester,	N. Y.	21
———,—Marine	G. L. Carver,	Brazil,	S. A.	7
——— Shafts,—Rollers for	Daniel S. Chase,	Augusta,	Ga.	14
Pruning Trees,—Instruments for	D. P. Chamberlin,	Hudson,	Mich.	7
Pumps,	Joseph Hardey,	Moline,	Ill.	21
———,—Chain,	Amos Coates,	Marlborough,	Ohio,	7
———	Wm. Shearer,	Atlanta,	Ga.	21
Quadrants,—Sinecal	A. M. Chisholm,	Antigonish,	N. S.	28
Quilting Frame,	J. L. Newton,	Black Brook,	N. Y.	28
Railroad Car Springs,	G. L. Turner,	City of	"	21
——— Windows,	Messer & Steinbrenner,	Cleveland,	Ohio,	14
——— Cars,—Journal-boxes	Harvey Rice,	Concord,	N. H.	7
——— Car Wheels,	Walter Youmans,	Waterford,	N. Y.	7
——— Cars,—Stop. & Start.	F. C. Kutt,	Hackensack,	N. J.	21
———	J. H. Wygant,	"	"	7
——— Switch,—Safety	H. N. Rhodes,	Richmond,	Vt.	28
——— Switches,—Operating	Simeon Heywood,	Claremont,	N. H.	28
———	G. K Hyde,	Brooklyn,	N. Y.	28
Railroads,—Construction of	Alexander Hay,	Philadelphia,	Penna.	21
———,—Sliding Switches for	H. N. Rhodes,	Richmond,	Vt.	28
Railway Bars,—Lock Joint for	Aaron Douglass,	Paterson,	N. J.	21
Rakes,—Horse	G. S. Kinsey,	Reading,	Penna.	28
Reaping Grain & Mowing Grass,	A. A. Henderson,	Huntingdon co.,	"	14
Reaping and Mowing Machines,	"	Philadelphia,	"	14
———	Elizabeth M. Smith,	Burlington,	N. J.	7
Refrigerator,	D. S. Heffron,	Utica,	N. Y.	7
Rice,—Machine for Cleaning	James Van Valkinburgh,	Binghampton,	"	21
———,—Machines for Hulling,	C. B. Horton,	Elmira,	"	28
Rotary Engines,	H. E. Emery,	Lincoln,	Ohio,	7
———	Cornelius Donovan,	E. Abingdon,	Mass.	7
———	B. A. Goodell,	Millbury,	"	14
———	P. B. Holmes,	Cincinnati,	Ohio,	28
——— Motion,—Reciprocat'g to	Elisha Matteson,	Brooklyn,	N. Y.	28
Rubber,—Devulcanizing Waste	A. C. Richard,	City of	"	21
Sack-fastener,	Thomas Hopkins,	Newport,	Ky.	21
Sad-iron,	W. M. Knight,	Buffalo,	N. Y.	28
Sails,—Working Ships	A. L. Simpson,	Durham,	N. H.	28
Sausage-filler,	J. G. Perry,	S. Kingston,	R. I.	28
Saw Blades,—Mach. for Grind'g	Henry Disston,	Philadelphia,	Penna.	21
———,—Reciprocating	Christian Germann,	Camden,	Mich.	21

Saw-set,	Wm. Clemson,	Middletown,	N. Y.	21
Sawmills,—Feed Motion for	E. G. Dyer,	Hamilton,	Ohio,	21
————,—Head Block for	J. W. Truax,	Richford,	Vt.	28
Saw Teeth,—Mach. for Setting	T. S. and H. Disston,	Philadelphia,	Penna.	28
Saws,—Tempering	Wm. Clemson,	Middletown,	N. Y.	21
Sawing Stone,—Machines for	A. M. Burnham,	Montpelier,	Vt.	21
Scaffolds,—Portable	R. M. Lytle,	Triune,	Tenn.	14
Screw Augers,—Casting	Carl & Heath,	Grenada,	Miss.	21
Scythe Fasteners,	C. L. Barritt,	City of	N. Y.	21
Seaming Machines,—Double	G. R. Moore,	Pittsburgh,	Penna.	28
Seeding Machines,	James Alsop,	Clinton,	Ill.	28
————	Edward Badlam,	Ogdensburgh,	N. Y.	28
————	Wm. S. Lawyer,	Gratiot,	Ohio,	7
————	M. H. Mansfield,	Ashland,	"	28
————	McElroy & Kimble,	Fox Lake,	Wis.	7
Seed Planters,	Leonard Harriman,	Anderson,	Ind.	21
————	J. P. Allen,	Dover,	Ga.	14
————	T. M. Green,	Milledgeville,	"	21
————	James McLaughlin,	Duncannon,	Penna.	28
————	J. R. Mills,	Bloomfield,	Iowa,	28
————	W. F. Schroeder,	La Porte,	Ind.	14
————	J. F. Tannehill,	Staunton,	Va.	14
————	Miller Warren,	W. Middleburg,	Ohio,	21
Sewing Machines,	David Haskell,	Georgetown,	Mass.	28
——— Machine Needles,	F. H. Drake,	Middletown,	Conn.	14
Ships Berth,—Oscillating	T. S. Brown,	Philadelphia,	Penna.	28
Shirt Stud,	Wm. F. Kubler,	City of	N. Y.	7
Shoe Cleaner,	Thomas Board,	Ripley,	Va.	28
—— Pegs,—Mach. for Pointing	S. G. Brett,	Newport,	N. H.	14
—— Pegging Machine,	C. A. Priest,	Winslow,	Me.	7
—— Tips,—Cutting & Swaging	Bearce & Peck,	N. Auburn,	"	28
Shutters & Awnings for windows,	Jacob David,	City of	N. Y.	21
Sofa Bedstead,	Tendler & Moeshlin,	Cambridge,	Mass.	28
Spading Machines,	Stuart Gwynn,	City of	N. Y.	28
Spinning Frames,—Driv. Bands	Slade & Scranton,	Bennington,	Vt.	7
————,—Tubes for	D. D. Allen,	S. Adams,	Mass.	7
Spoons,—Mach. for Burnishing	H. M. Jacobs,	Hartford,	Conn.	14
Springs,—Carriage	G. H. Laub,	Newark,	Mo.	14
———,—Wagon	Nicholas Jenkins,	City of	N. Y.	14
Stalk and Root-cutters,	Frederick Fidler,	Batavia,	"	28
Steam,—Method of Generating	Stuart Gwynn,	City of	"	7
——— Boilers,	G. W. Rains,	Newburg,	"	14
————,—Low-wat. Alar.	C. H. Brown,	Fitchburgh,	Mass.	7
——— Engines,	G. W. Van Deren,	Big Flats,	N. Y.	14
————,—Condensers	B. F. Lemmon,	New Albany,	Ind.	7
————,—Governors for	C. P. Buckingham,	Mt. Vernon,	Ohio,	7
————————	R. W. Gardner,	Quincy,	Ill.	14
————,—Pistons for	H. D. Dunbar,	Memphis,	Tenn.	14
————————	Robinson & Clark,	Bellaire,	Ohio,	14
————,—Slide Valves	L. P. Rice,	Adrian,	Mich.	28
————,—Valve Gear	Patrick Kenney,	Providence,	R. I.	14
————————	Peter Louis,	City of	N. Y.	28
——— Gauges,	Albert J. Allen,	Buffalo,	"	14
Steering Apparatus,	Nathaniel Snow,	Boston,	Mass.	14
Stop-cocks,	H. A. Chapin,	Springfield,	"	21
Stoves,	Wm. F. George,	Cincinnati,	Ohio,	21
———	Magee & Towne,	Lawrence,	Mass.	14
———	J. S. and M. Peckham,	Utica,	N. Y.	7
———	J. Stuber and others,	"	"	7
Straw-cutters,	D. B. Caldwell,	Cincinnati,	Ohio,	7
————	E. D. Lady,	Nashville,	Tenn.	28
Stump Extractors,	J. B. Lyons,	Milton,	Conn.	14

Stump Extractors,	Wm. & Daniel Kimmel,	Cambridge C'y,	Ind.	14
Surveyors Instrument,	Able Ware,	Athens,	Me.	28
——— Leveling Instruments,	Lorenzo Lea,	Jackson,	Tenn.	21
——— Measure,	W. H. Paine,	Sheboygan,	Wis.	7
Sweeping Machine,—Street	Jacob Edson,	Boston,	Mass.	14
Table,—Circular	J. F. Finger,	Marion,	S. C.	24
Tacks,—Applying Washers to	J. G. Howard,	S. Braintree,	Mass.	28
Tanks,—Construction of Stone	L. B. Darling,	Providence,	R. I.	21
Tanning,—Compositions for	Alexander Hill,	Dubuque,	Iowa,	7
——— Apparatus,—Construc.	Dennis Aldrich,	St. Louis,	Mo.	21
Telegraphic Apparatuses,	L. Bradley,	City of	N. Y.	28
——— Instruments,	David Flannery,	Jackson,	Miss.	21
———	E. F. Reynolds,	West Farms,	N. Y.	21
Telegraphs,—Lightning-arrester	D. F. S. Ways,	Baltimore,	Md.	7
Tenoning Frame,	Asa Greenwood,	Toulon,	Ill.	14
Thills to Vehicles,—Attaching	E. H. Plant,	Plantsville,	Conn.	14
Thread,—Dressing and Finish'g	Hall & Merrick,	W. Willington,	"	21
———	"	"	"	7
Threshing Machines,—Cylinders	L. and E. Whitman,	Winthrop,	Me.	21
Tires,—Machine for Bending	Wm. Bailey,	London Grove,	Penna.	14
Tire,—Machine for Upsetting	Orlando Foster,	Kenosha,	Wis.	7
———	Olmstead & Walker,	Victoria,	Ill.	7
———	C. V. Statler,	Wataga,	"	7
Tool Handles,	J. G. Rogers,	San Francisco,	Cal.	14
Trace-fastener,	Sylvenus Walker,	Boston,	Mass.	28
Traps,—Animal	George Slusser,	Hillsboro',	Ohio,	14
Trap,—Steam	Nehemiah Upham,	Norwich,	Conn.	28
Tree Protector,	W. W. Taylor,	S. Dartmouth,	Mass.	21
Trunks,	S. Bourne, Jr.,	City of	N. Y.	7
Trusses,—Construct. of Hernial	L. B. White,	Moscow,	"	21
Turbine Water Wheels,	Bradford Stetson,	Uxbridge,	Mass.	14
Umbrellas,	J. P. Schenkl,	Boston,	Mass.	21
Vinegar,—Manufacture of	John Palmer,	Fort Scott,	Kansas,	7
Washing Machine,	S. T. and David Adams,	Medina,	Ohio,	21
———	J. S. Davis,	Tiffin,	"	14
———	Hugunin & Whitney,	Cleveland,	"	21
———	Solomon Hunt,	Danville,	Ind.	28
———	Patterson & Ramsey,	Kingston,	Tenn.	21
———	H. E. Smith,	Philadelphia,	Penna.	28
———	A. Threlkeld,	Boone co.,	Ind.	14
Washstand,—Fountain	J. R. Ender,	Trenton,	La.	7
Watches,—Lever Escapement	John Devlin,	Philadelphia,	Penna.	14
Water Elevators,	Hiram Nash,	Maysville,	Ky.	7
——— from Wells,—Delivering	James Dakin,	Cleveland,	Ohio,	21
——— Wheels,	John Blocher,	Williamsville,	N. Y.	7
———	Adolphus Lind,	San Francisco,	Cal.	7
———	H. G. Nelson,	Lockport,	N. Y.	28
Wheels for Vehicles,	T. C. Hendry,	Conyers,	Ga.	7
———,—Holder for Polishing	E. W. Nichols,	Worcester,	Mass.	7
Willow-peeler,	J. M. Wood,	Seneca,	N. Y.	7
Window Shade Fixture,	R. B. Burchell,	Brooklyn,	"	7
——— Washer,	John Middleton,	City of	"	28
Wrenches,	E. S. Scripture,	"	"	28
Wrench and Pincers,	Ezra Ripley,	Troy,	"	14
——— Vise,	Wm. Russell,	Stoughton,	Mass.	14

EXTENSIONS.

Brides,—Truss	Wm. Howe,	Springfield,	Mass.	28
Screws,—Cutting Wood	T. W. Harvey,	City of	N. Y.	28
———,—Wood	T. J. Sloan,	Paris,	France,	28

ADDITIONAL IMPROVEMENTS.				
Churn,	M. L. Bauder,	Cleveland,	Ohio,	7
Lamps,	Alburtus Geiger,	Dayton,	"	14
RE-ISSUES.				
Fire Arms,—Revolving	J. M. Cooper,	Pittsburgh,	Penna.	21
—— Plugs,	J. L. Lowry,	"	"	21
Gases,—Appa's for Naphthaliz'g	E. H. Ashcroft,	Boston,	Mass.	14
Hat-bodies,—Mach. for Making	A. B. Taylor,	City of	N. Y.	21
Lamp Shades,	Chas. & A. C. Wilhelm,	Philadelphia,	Penna.	21
Shoes,—Wooden-soled	Henry Wight,	Cambridge,	Mass.	7
Steam Boilers,—Safety Apparat.	Timothy Clark,	Bedford,	N. Y.	28
Stoves,	P. N. Burke,	Buffalo,	"	21
Water from Wells,—Drawing	J. W. Wheeler,	Cleveland,	Ohio,	21
DESIGNS.				
Carpet Patterns (3 cases),	E. J. Ney,	Lowell,	Mass.	7
———— 8 "	H. G. Thompson,	City of	N. Y.	7
Coffins,	J. P. Cunningham,	Franklin,	Tenn.	14

FRANKLIN INSTITUTE.

Proceedings of the Stated Monthly Meeting, October 19, 1860.

John Agnew, Vice-President, in the chair.

Isaac B. Garrigues, Recording Secretary.

The minutes of the last meeting were read and approved.

Letters were read from the Royal Geographical Society.

Donations to the Library were received from the Royal Society, the Royal Geographical Society, the Statistical Society, and the Chemical Society, London; L. A. Huguet Latour, Esq., Montreal, Canada; W. H. Schock, Esq., U. S. Navy, Baltimore, Maryland; Frederick Emmerick, Esq., Washington D. C.; J. Disturnell, Esq., Alfred W. Craven, Esq., City of New York; G. B. Prescott, Esq., Boston, Mass.; and from Messrs. A. L. Elwyn, Francis Wharton, and Prof. John F. Frazer, Philadelphia.

The Periodicals received in exchange for the Journal of the Institute, were laid on the table.

The Treasurer's statement of the receipts and payments for the month of September was read.

The Board of Managers and Standing Committees reported their minutes.

Twenty resignations of membership in the Institute were read and accepted.

Candidates for membership in the Institute (18) were proposed, and the candidates proposed at the last meeting (9) duly elected.

Mr. J. E. Wootten exhibited a model of Andrews and Carr's patent Lubricator for car journals or other end bearings. It consists in introducing the oil for lubrication into a chamber formed by boring a cylindrical hole into the end of the axle of a depth about equal to the length of the journal. A small hole is bored from the surface of the journal to communicate with the chamber, and through this orifice the oil reaches the bearing. A tube for containing oil fills the chamber. Upon the insertion of this tube with its charge of oil, the chamber is closed by means of an annular screw-plug, in which is inserted a disk of plate glass, which serves the admirable purpose of affording an opportunity of observing at a glance what quantity of oil the chamber contains, and when the supply should be replenished. Experimental tests which have been made with this lubricator, show it to be very economical and efficient in its performance.

A Seed-planter and Horse-rake combined, was presented to the notice of the members. It is patented by Russell & Wiley, of Chester co., Pa., and is claimed to have the following advantages :—

1st. It can be used as a grain drill, sowing, with much accuracy, wheat and oats.

2d. With a little alteration, it is changed to a corn planter, either checkering the grain, or sowing it in one continuous line.

3d. It can be changed in a few minutes time into a horse-rake.

4th. It also has a grass-seed sower attached.

The patentees say, that the machine can be furnished at the same price as an ordinary grain drill.

Mr. Howson exhibited a specimen of Messrs. Dietrich and Bridge's Patent *Hose Protector.* It consists of two sheets of gum elastic or other equivalent flexible material fastened together at one end, the lower sheet being furnished with transverse strips. When a fire occurs in the neighborhood of streets having railways traversed by passenger cars, two of these patent hose protectors are placed one on one rail, and the other on the opposite rail of the track. The upper sheets of the protectors are then thrown back, the lower sheets placed beneath the hose, and the upper sheets folded over the latter. The cars are then allowed to pass over the protectors, which serve to prevent the wheels from injuring the hose or interrupting the flow of water through the same, the direct course of the cars being in no way interfered with. These protectors have been submitted to such practical tests as fully prove their efficiency.

BIBLIOGRAPHICAL NOTICE.

History, Theory, and Practice of the Electric Telegraph. By George B. Prescott. Boston: Ticknor & Fields, 1860.

The subject of this well-written work is one of great interest to an American, not only on account of its practical importance, but because he may legitimately feel proud of the numerous and valuable improvements in it, which are due to his countrymen. The work of Mr. Prescott gives a very good account of the electric telegraph. It contains a very full description of the principal inventions in the art, and these descriptions are concise, lucid, and abundantly illustrated by excellent wood-cuts. There is every evidence of a disposition to be fair toward all inventors, American and foreign;—so that although we think a very manifest bias against Mr. Morse is shewn, yet we doubt not, it was quite unintentional in the writer. If, however, he believes that Mr. Morse did not devise the local circuit, it would have been more instructive for us, if he had shown us who did and when. But, after all, this bias does not prevent a very fair account of what Morse's Telegraph is, and what Mr. Morse claims, which is all the public generally want to know. The book is of course excellently got up by the publishers, and will constitute a very valuable addition to the libraries of those who want to know the history and the theory of the electric telegraph.

METEOROLOGY.

For the Journal of the Franklin Institute.

The Meteorology of Philadelphia. By JAMES A. KIRKPATRICK, A.M.

SEPTEMBER.—The temperature of the month of September was a little more than two degrees below the average temperature for the last ten years, and about half a degree below the average of September, 1859. The daily oscillation, as well as the mean daily range of temperature, was greater than usual.

The warmest day was the 8th, of which the mean temperature was 80·3°. The highest degree indicated by the thermometer was 92°, on the same day. From two o'clock on the afternoon of the 8th, till the same hour on the 9th, the temperature fell 24°.

The temperature was lowest on the night of the 29th, when the register thermometer indicated 42°; and the next day, the 30th, was the coldest day of the month, the average temperature of that day being 48·3°.

The pressure of the atmosphere was greater than usual, the average height of the barometrical column being thirteen hundredths of an inch higher than for September, 1859, and nearly three hundredths of an inch higher than the average for the last ten years.

The barometric column stood highest on the evening of the 30th, when it indicated 30·313 inches, after being reduced to the temperature of 32°. It was lowest on the afternoon of the 25th, when it marked 29·597 inches.

The force of vapor and the relative humidity were again below the average.

There was but one day of the month on which the sky was completely clear or free from clouds, and not one on which the sky was entirely covered with clouds at the hours of observation.

Rain fell at Philadelphia on seven days of the month, to the aggregate depth of 2·907 inches, which is nearly an inch below the average for the month, and five inches less than the amount which fell in September of last year.

The equinoctial storm, visited us in the shape of a heavy shower of rain on the morning of the 20th. It commenced at half past one, and ceased at half past six, during which time an inch and three-quarters of rain fell. Several showers also fell between four and half past ten in the evening, accompanied with thunder and lightning. No damage whatever was sustained at Philadelphia, though the papers from other parts of the country record the destruction of a considerable amount of property by wind and flood. From the 11th till the 14th, a large quantity of rain fell in parts of New York and New England. On the 15th, there was a terrible storm in the Gulf of Mexico, the wind first from the north-west and then from the north, causing the loss of some very valuable merchant ships. At Mobile, the water rose far above the wharves and above the level of the streets, and destroyed a great quantity of merchandize. On the evening of the 19th, another heavy rain storm commenced, and extended from the Hudson River to beyond Lancaster, Pa.

The first appearance of hoar frost observed this season, was on the morning of the 28th.

The winds during the month, as will be seen by the following table of comparisons, were more southerly than usual.

A Comparison of some of the Meteorological Phenomena of September, 1860, *with those of September*, 1859, *and of the same month for ten years, at Philadelphia.*

	Sept., 1860.	Sept., 1859.	Sept., 10 years.
Thermometer.—Highest,	92°	82°	95°
“ Lowest,	42	45·5	39
“ Daily oscillation,	18·20	18·10	17·00
“ Mean daily range,	5·20	4·10	4·80
“ Means at 7 A. M.,	60·28	61·02	62·58
“ “ 2 P. M.,	73·17	72·88	74·91
“ “ 9 P. M.,	64·02	64·65	66·63
“ “ for the month,	65·82	66·18	68·04
Barometer.—Highest,	30·313 in.	30·179 in.	30·430 in.
“ Lowest,	29·597	29·338	29·338
“ Mean daily range,	·143	·119	·121
“ Means at 7 A. M.,	30·003	29·875	29·985
“ “ 2 P. M.,	29·965	29·835	29 943
“ “ 9 P. M.,	29·998	29·863	29·961
“ “ for the month,	29·989	29·858	29·963
Force of Vapor.—Means at 7 A. M.,	·425 in.	·438 in.	·474 in.
“ “ “ 2 P. M.,	·437	·462	·494
“ “ “ 9 P. M.,	·455	·472	·515
Relative Humidity.—Means at 7 A. M.,	77 per ct.	79 per ct.	79 per ct.
“ “ “ 2 P. M.,	50	59	55
“ “ “ 9 P. M.,	72	76	74
Rain, amount in inches,	2·907	7·779	3·747
Number of days on which rain fell,	7	11	8
Prevailing winds,	s. 74°26′w·397	n. 70°38′w·236	s. 88°22′w·220

Abstract of Meteorological Observations for August, 1860 made in Philadelphia, Franklin, and Somerset Counties, Pennsylvania, for the Committee on Meteorology of the Franklin Institute.

1860.	PHILADELPHIA.—Lat. 39° 57′ 28″ N. Long. 75° 10′ 28″ W. Height above the sea 50 feet. Prof. J. A. KIRKPATRICK, Observer.									CHAMBERSBURG, Franklin Co. Lat. 39° 58′ N. Long. 77° 45′ W. Height 618 ft. WM. HEYSER, Jr., Obs.							SOMERSET, Somerset Co. Lat. 40° N. Long. 79° 3′ W. Height 2195 feet. GEO. MOWRY, Observer.						
Aug.	Barometer.		Thermometer.			Force of vapor.	Relative humidity.	Rain.	Prevail'g winds.	Barom	Thermom.		Force of vapor.	Relative humidity.	Rain.	Prevail'g winds.	Barom	Thermom.		Force of vapor.	Relative humidity.	Rain.	Prevail'g winds.
	Mean.	Mean daily range.	Mean.	Daily oscillation.	Mean daily range.	2 P.M.	2 P.M.			Mean.	Mean.	Mean daily range.	2 P.M.	2 P.M.			Mean.	Mean.	Mean daily range.	2 P.M.	2 P.M.		
	Inch.	Inch.	°	°	°	Inch.	Per ct.	Inches.	Direc.	Inch.	°	°	Inch.	Per ct.	Inch.	Direc.	Inch.	°	°	Inch.	Per ct.	Inch.	Direc.
○ 1	29·875	·245	74·0	19	7·7	·275	27		N W.	29·312	71·0	4·0	·483	56		(var.)	27·770	61·0	7·0	·600	65		W.
2	29·972	·097	74·2	25	2·8	·419	35		(var.)	29·407	74·7	5·0	·585	55		(var.)	27·812	67·7	6·7	·643	58		W S W
3	29·932	·044	75·3	20½	1·5	·538	46		S E.	29·409	75·7	3·7	·690	70		W.	27·792	72·7	5·7	·737	69		S.
4	29·809	·123	81·0	24½	5·7	·729	55	0·150	S S W.	29·307	82·0	5·7	·752	53		W.	27·737	80·7	7·7	·826	57		(var.)
5	29·811	·050	83·0	17	3·3	·520	36		N W.	29·350	83·3	2·7	·796	56		W.	27·734	76·0	4·3	·813	82	0·489	W.
6	29·884	·074	80·7	21	2·3	·481	35		N E.	29·368	81·3	3·3	·719	58		(var.)	27·762	75·7	5·0	·804	65		S S W.
7	29·802	·083	82·8	23	2·5	·616	40		S S W.	29·255	83·7	2·3	·721	53		W.	27·705	78·0	3·7	·900	59	0·128	S W.
8	29·694	·107	82·2	20	1·3	·792	54	0·007	S W.	29·084	81·0	3·0	·705	55	0·010	W.	27·629	74·7	3·3	·745	64	0·037	W.
☾ 9	29·686	·037	81·8	18	1·0	·567	40		(var.)	29·087	80·7	1·3	·596	48		W.	27·620	75·3	0·7	·683	56		W.
10	29·733	·047	82·7	23	0·8	·703	45		S W.	29·144	80·0	5·3	·651	45	} 0·785	W.	27·655	72·7	4·0	·822	62	0·665	W.
11	29·804	·071	71·0	13	11·7	·599	78	0·145	N N W.	29·241	74·7	7·3	·577	64		(var.)	27·707	65·3	7·3	·588	74	0·024	W.
12	29·872	·087	74·7	21	4·0	·566	52		N E.	29·261	76·7	3·3	·731	67	} 2·740	E.	27·717	69·0	5·7	·630	61		(var.)
13	29·711	·161	76·0	18	4·7	·850	77	4·617	(var.)	29·125	69·0	7·7	·586	80		E.	27·632	60·3	9·3	·436	80	0·580	N W.
14	29·845	·134	65·0	8½	11·0	·524	77	2·140	N W.	29·312	67·0	2·7	·469	62		E.	27·771	58·0	5·7	·424	64		N W.
15	29·971	·126	67·0	21	3·3	·367	43		N.	29·422	66·0	0·7	·572	75		E.	27·850	59·7	3·7	·389	50		N N E
● 16	30·013	·042	69·0	23	2·0	·382	41		N E.	29·437	69·0	3·3	·577	64		E.	27·852	62·7	3·0	·456	49		S E.
17	29·941	·072	71·5	24	2·5	·486	46		S W.	29·304	71·0	1·7	·678	73		E.	27·784	69·7	7·0	·655	56		W S W
18	29·762	·179	75·7	24½	4·2	·671	57	0·270	S W.	29·131	75·7	7·0	·746	64	0·125	S E.	27·648	71·7	3·3	·648	54	0·017	W.
19	29·808	·067	78·2	21	2·5	·650	52		(var.)	29·212	76·7	2·3	·762	61		E.	27·667	71·3	3·7	·747	58		W.
20	29·926	·118	78·3	14½	1·8	·750	62		(var.)	29·292	77·7	1·7	·733	61		E.	27·703	72·3	1·7	·804	65		S.
21	29·942	·023	76·3	12	2·0	·790	72	0·812	S E.	29·275	77·7	2·0	·718	64	0·725	W.	27·712	67·7	7·3	·635	90	1·340	W.
22	29·914	·027	76·2	15	1·5	·713	63	0·096	(var.)	29·278	73·3	4·3	·731	82		E.	27·702	69·7	2·7	·627	72	0·047	S E.
☽ 23	29·877	·038	78·5	18	2·3	·728	58	0·149	E.	29·201	75·3	2·0	·758	74	} 0·310	E.	27·655	72·0	2·3	·619	63	0·017	S S E.
24	29·749	·128	75·7	10½	4·2	·728	73	0·399	E.	29·071	75·3	3·3	·704	73		E.	27·576	71·7	4·3	·689	57	1·045	W.
25	29·656	·093	78·0	15	3·7	·671	54	0·455	W N W	29·082	73·7	2·3	·550	57		(var.)	27·535	66·0	5·7	·567	67	0·194	W.
26	29·750	·095	72·8	17	5·2	·495	50		W N W	29·175	71·3	2·3	·420	52		(var.)	27·617	61·3	4·7	·510	63		W.
27	29·795	·045	75·3	22	2·8	·500	43	0·015	S W.	29·169	69·3	4·0	·595	76		W.	27·616	63·3	2·0	·513	53		W.
28	29·787	·026	68·8	10	6·8	·458	55	0·005	N.	29·177	62·3	4·0	·510	89	0·170	W.	27·606	57·0	9·0	·498	91	0·379	?
29	29·872	·085	67·3	20	3·8	·363	40		N W.	29·270	64·3	4·3	·398	56		N W.	27·715	54·7	5·7	·393	59		N W.
30	29·895	·072	70·2	24	2·8	·481	47		S W.	29·214	68·3	5·0	·541	68		S E.	27·660	62·7	8·0	·448	52		W S W
○ 31	29·692	·203	75·2	21	5·0	·700	63		S W.	29·037	70·7	5·7	·601	65		W.	27·547	66·0	7·3	·428	51	0·158	W.
Means	29·832	·090	75·4	19	3·8	·584	52	9·260	N 81° W	29·270	73·5	3·7	·637	63	4·865	S 53° W	27·693	68·0	5·1	·621	63	5·120	S 76° W

Abstract of Meteorological Observations for August, 1860; *made in Adams, Dauphin, Northumberland, Centre, and Armstrong Counties, Pennsylvania, for the Committee on Meteorology of the Franklin Institute.*

1860.	Gettysburg, Adams Co. Lat. 39° 49′ N. Long. 77° 18′ W. Ht. 624 ft. Prof. M. Jacobs, Obs.					Harrisburg, Dauphin Co. 40°16′, N. 76°50′, W. Ht., 300 ft. John Heisely, M.D., Obs.					Shamokin, Northumberland Co. 40° 45′ N. 76°30′ W. Height, 700 ft. P. Friel, Obs.				Fleming, Centre Co. 40° 55′ N. 77° 53′ W. Ht., 780 feet. S. Brugger, Obs.				Freeport, Armstrong Co. 40° 44′ N. 79°42′ W. Height, 1000 feet. J. H. Baird, Obs.		
	Barom	Thermom.		Rain.	Pre-vail'g winds.	Barom	Thermom.		Rain.	Pre-vail'g winds.	Thermom.		Rain.	Pre-vail'g winds.	Thermom.		Rain.	Pre-vail'g winds.	Thermometer.		Prevail-ing winds.
Aug.	Mean.	Mean.	Mean daily range.			Mean.	Mean.	Mean daily range.			Mean.	Mean daily range.			Mean.	Mean daily range.			Mean.	Mean daily range.	
	Inch.	°	°	Inch.	Direc.	Inch.	°	°	Inch.	Direc.	°	°	Inch.	Direc.	°	°	Inch.	Direc.	°	°	Direc.
○ 1	29·519	70·3	4·3		N W.	29·779	73·7	5·3		N.	62·0	9·7		W.	65·3	7·7		N W.	62·7	5·0	W.
2	29·586	74·3	6·3		S W.					S.	65·0	7·7		W.	69·7	4·3		(var.)	70·3	7·7	?
3	29·532	74·7	5·3		S.	29·823	78·0			S E.	72·7	11·0		(var.)	70·0	7·0	0·050	(var.)	74·3	4·7	W.
4	29·416	81·7	7·0		S W.	29 679	84·3	6·3		(var.)	82·0	9·3		W.	77·7	7.7	0 330	W.	78·7	4·3	W.
5	29·344	83·0	3·3		(var.)					N.	77·3	4·7		W.	74·3	4·0		W.	75·7	4·3	?
6	29·482	82·0	2·3		(var.)	29·744	85·0			E.	76·7	4·3		W.	77·7	4·0		(var.)	74·3	2·0	?
7	29·389	84·0	2·0		S S W.	29·645	86·3	1·3		(var.)	81·3	5·0		E.	81·0	3·3		E.	78·7	4·3	W.
8	29·276	82·7	1·3		S W.	29·543	86·7	1·7		S W.	80·7	3·3		E.	81·0	4·0		(var.)	75·3	4·7	?
☾ 9	29·294	82·3	1·0		S W.	29·558	84·7	2·0		(var.)	79·0	3·0		(var.)	77·0	4·7		W.	74·7	1·3	?
10	29 325	79·7	6·0	0·150	S W.	29·593	84·0	3·3	0·727	(var.)	78·7	3·0	0·200	W.	79·0	2·7	0·050	W.	73·3	2·0	?
11	29·449	71·0	8·7	0·130	N E.	29·718	74·3	6·3		N.	66·0	12·7	0·662	E.	68·3	10·7	0·350	W.	64·0	9·3	N.
12	29·479	73·3	2·3	2·315	(var)	29·763	75·3	3·7	3·945	S E.	69·0	9·0		S E.	70·3	2·7	1·250	S W.	69·7	8·3	S W.
13	29·323	65·3	8·0		(var.)	29·592	70·3	8·3		(var.)	65·0	12·7	2·042	S W.	66 3	6·0		W.	62·3	8·7	N.
14	29·507	67·7	2·3		N.	29·768	68·3	3·3		N.	62·7	5·0	1·371	(var.)	62·3	4·0		(var.)	60·7	2·3	?
15	29·647	63·0	5·3		N.	29·913	68·3	2·0		N.	60·0	6·7		W.	61·0	4·7		(var.)	59·7	1·0	N.
● 16	29·639	65·3	2·3		(var.)	29·925	69·0	1·3		(var.)	60 7	3·3		E.	62·0	1·0		(var.)	65·3	5·7	S W.
17	29·521	69·0	3·7		(var.)	29·774	73·7	4·7		(var.)	68·0	7·3		S E.	69·3	7·3		W.	69·0	4·3	W.
18	29·336	74·7	5·7	0·125	S W.	29·604	77·3	3·7		(var.)	73·7	6·3	0·380	(var.)	71·3	2·0		W.	73·7	6·0	W.
19	29·415	74·7	3·3		S W.	29·677	79·0	1·7		N.	74·3	2·7		S E.	73·3	2·0		(var.)	73·3	2·3	?
20	29·491	77·7	3·0		S W.	29·763	80·0	1·7		(var.)	76·7	2·3		S W.	76·0	2·7		S W.	76·0	2·7	W.
21	29·483	78·0	1·7	0·255	S W.	29·764	79·7	1·7	2·539	S.	77·7	5·0	0·528	S E.	74·7	2·7	0·050	S W.	73·7	2·3	W.
22	29·479	73·0	5·0	0·110	S W.	29·748	76·3	3·3	0·124	N E.	74·0	3·7	0 550	(var.)	73·7	1·7		(var.)	72·7	1·0	S E.
☽ 23	29·421	75·7	2·7	0·130	S.	29·721	77·7	2·0	0·255	(var.)	76·0	2·0	0·115	E.	72·3	3·3		(var.)	74·3	1·7	N E.
24	29·314	74·3	1·3	0·090	S E.	29·623	76·7	1·7	0·089	E.	74·0	2·7	0·642	E.	72·0	3·0	0·865	(var.)	70·0	4·3	N W.
25	29·243	74·0	1·0	0·017	(var.)	29·493	76·3	2·3		W.	73·3	0·7	0·172	W.	68·7	5·3	0·380	W.	64·0	6·0	W.
26	29·359	69·0	5·0		N W.	29·624	73·3	3·0		W.	64·7	8·7		W.	67·0	3·0		(var.)	64·7	3·3	?
27	29·364	68·3	2·0		S W.	29·637	73·0	1·7		S W.	66·7	10·0		S E.	68·0	3·0		W.	65·7	1·0	?
28	29·378	62·3	8·7	0·280	N N E.	29·656	66·0	8·3	0·148	N E.	59·0	7·7		(var.)	63·3	5·3		W.			N W.
29	29·469	62·0	6·3		N N W.	29·738	66·7	5·3		(var.)	56·7	3·0		(var.)	61·3	4·7		N W.	59·3		N W.
30	29·429	66·3	4·3		S W.	29·710	71·0	4·3		S W.	62·7	6·0		(var.)	62·7	6·0		S W.	66·3	8·3	(var.)
○ 31	29·226	70·0	4·3		W.	29·490	73·7	4·0		(var.)	70·0	10·0		S W.	66·3	11·0		W.	63·0	8·7	N W.
Means	29·446	73·2	4·1	3·602	s 67° w	29·692	76·2	3·5	7·827	N 16° E	70·5	6·1	6·662	s 3° w	70·4	4·6	3·325	s 77° w	69·5	4·4	N 68° w.

JOURNAL

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OF THE STATE OF PENNSYLVANIA,

FOR THE

PROMOTION OF THE MECHANIC ARTS.

DECEMBER, 1860.

CIVIL ENGINEERING.

For the Journal of the Franklin Institute.

Report on the Condition of the Niagara Railway Suspension Bridge, 1860. By JOHN A. ROEBLING, Civ. Eng.

To the Presidents and Directors of the Niagara Falls Suspension, and Niagara Falls International Bridge Companies.

GENTLEMEN :—After an absence of two years, I have again visited the Niagara Railway Suspension Bridge, and have, during a stay of three days, on the 18th, 19th, and 20th of July, made a thorough examination of the work. I now present to you the following report :

The Niagara Bridge was opened for railway traffic on the 18th of March, 1855; the lower floor for common travel was completed and in use the year previous. The number of trains and trips of single engines, which at the present time pass over the Bridge in twenty-four hours, averages about forty-five. This great traffic accounts for the rapid wear of the rails, many of which require renewal.

After a thorough examination of all parts of the work, I am unable to report any change.

The camber of the floors and the deflection of the cables, as you well know, depend upon the temperature of the atmosphere. The relative level of the floors is the same as it was in 1855.

In order to be better enabled to judge whether the stiffness of the superstructure has been impaired by a five years traffic, I placed a leveling instrument between the towers on the New York side, and observed the process of gradual deflection caused by five trains.

A train, composed of the engine "Essex," and tender, of 35 tons weight, drawing 10 empty cars, produced a deflection in the centre of	0·462	feet.
A small engine, drawing 2 loaded passenger cars, 1 baggage car, and 1 loaded cattle car, ...	0·510	"
Another light engine, with 5 loaded passenger cars, and 1 baggage car,	0·520	"
The engine "Essex," and tender alone, . .	0·315	"
The same engine returning with 8 loaded cattle cars, each holding 17 to 18 cattle of the largest size, . . .	0·789	"

A short but heavy train, such as the last, when in the centre of the Bridge between the stays, produces the greatest deflection comparatively. A longer train, loaded at the same rate, and extending over the limits of the stays, deflects the work but little more. In proportion, as the ends of the floor are weighed down, the centre is kept up. By comparing the above observations with those of 1855, we discover no essential difference. The great experimental train, which covered the whole Bridge with loaded cars, propelled by two engines, produced a deflection of ten inches. A similar train passed over now will do the same.

The extreme rise and fall of the floor, owing to the contraction and expansion of the cables, amounts to more than two feet. But the cables being at liberty to contract and expand, this process can never affect their strength.

In my report of 1855 I stated the aggregate ultimate strength of the 4 suspension cables at . . .	12,000	tons.
Permanent weight, supported by cables, . .	1,000	"
Tension resulting, . . .	1,810	"
Proportion of permanent tension to strength, . .	1 : 6·63	
Tension produced by a train of 250 tons, . .	452	"
Aggregate tension, ...	2,262	"
Proportion of working tension to strength, . .	1 : 5·30	

This liberal allowance of strength and freedom from vibration will insure the durability of the cables.

The question has been repeatedly asked, why trains are not allowed to pass over this Bridge at a higher rate of speed than five miles an hour? This limitation is looked upon as a sign of tacitly acknowledged weakness, and has been frequently referred to as a strong argument against suspension bridges for railway purposes.

This matter I discussed in my report of 1855, but I will explain again and more fully. The first great object of this limitation of speed is *safety*. Although it may look somewhat timid in this fast-going age, to see freight trains move at the rate of five miles per hour, and passenger trains at even a less rate, yet when it is considered that this slow speed insures *absolute safety*, no matter what accident may happen to a train—the traveling community ought to be satisfied with this cautious arrangement. What would be gained by a higher speed? Nothing whatever. The Bridge forms a link between two termini, and there is always time to make connections. Passengers will prefer to cross at a slow rate in order to enjoy the splendid scenery during the passage. The track is so constructed as to form a trough of three feet depth between the girders, into which a car or locomotive will instantly drop, the moment it breaks down or leaves the track—provided there is no great headway. Should such an accident happen to a train, the broken-down car, engine, or track, will act as a powerful brake, and will check its motion. When planning the work, absolute safety was made the first condition, and the track has been constructed accordingly. I would also remark in this connexion, that any further addition of fender-pieces to the track, as an additional means of safety, as has been proposed of late, would only prove an unnecessary incumbrance.

A greater speed than five miles per hour for passenger trains should never be permitted for the reasons stated. But should a much heavier freight business have to be accommodated in the future, the speed of freight trains may be increased without injury to the work. All that will be necessary is, to keep the track in perfect order, and to maintain a continuous bearing at the rail joints to prevent concussions. I will further state here, that by an additional expenditure of $20,000, the stiffness of the Bridge may be so far increased as to admit of the highest practicable speed of freight trains, without producing the slightest injurious effect upon the structure. I make this statement deliberately for the information of those professional and unprofessional opponents to suspension railway bridges, who have made it their business to cast doubts upon the permanency of this work. I also expect to demonstrate this when resuming the works on the Kentucky River Bridge, on the Lexington and Danville Railroad, which, when completed, will form a single span of 1224 feet from centre to centre of towers, over a chasm of 300 feet deep.

The wood-work of the Niagara Bridge, being kept well painted, and otherwise well protected, will last forty years and more. The old wooden St. Clair Bridge, at Pittsburgh, Penna., which I removed to make room for a new suspension bridge, recently completed, has stood exactly forty years. All its principal timbers of pine and oak, on removal, were found good and sound. A portion of this material, after being well tarred, has gone into the new suspension floor, and will no doubt render good service for another forty years.

My views of the durability of the cables have undergone no change since 1855; they have only been strengthened by additional experience. This being a subject of great importance and of general interest, I embrace this opportunity to express myself more fully, and thus perhaps to contribute towards a better understanding of the nature of iron.

The fact is well known, that wrought iron under certain conditions will undergo certain radical changes. And so will all kinds of matter. The material universe is not by any means constituted upon the principle of *immutability*. Material existence is but a theatre of change, of breaking down, of reduction, and of reconstruction of the elements of matter. The Egyptian pyramids are even now undergoing a slow process of disintegration. The dry air of that region, slow in action, is still sure to do its appointed work. And as all human fabrics, being but material constructions, will have to succumb to the same inexorable law, we cannot expect that the Niagara Bridge will form an exception.

Two kinds of changes are known, which will affect the strength of iron and other metals. The one is wrought by the chemical process of oxidation, and can be guarded against effectually, and is so guarded in the Niagara Bridge. All iron and wire within reach, are kept well painted, and thus preserved against rust. The anchor chains and their connexions with the cables, inside of the anchor masonry and in the rock below, after three coats of paint, are protected by the cement grout, which forms a solid envelope, excluding air and moisture.

But aside from the mechanical protection thus afforded, I depend principally, as was explained in my report of 1855, upon the well-known chemical action of calcareous cements in contact with iron. Oxygen has a greater affinity for lime than for iron. So long, therefore, as the cement will combine with oxygen, or, in other words, has not become completely crystallized, which is a very slow process inside of heavy masonry, the iron will be protected. The cement, not exposed to the air, when setting slowly, has a tendency rather to expand than to contract; but suppose there should be cracks around the anchor bars, large enough to admit air and moisture. Water will then find its way through those cracks, but on reaching the iron, will be more or less impregnated with cement, and thus add another protecting coat. The chemical principle, which I have explained here, I apply daily in my factory for the preservation of wire against dampness. I have also carried on direct experiments for a number of years, which have convinced me of the preserving property of calcareous cements in damp situations.

On examining recently the anchor bars of the Monongahela Suspension Bridge at Pittsburgh, built sixteen years ago, I found them perfectly preserved, as far as the cement, in which they are embedded, was removed. To satisfy yourself on this subject, I shall propose in a few years more, to remove the anchor blocks and to examine the upper links of the anchor chains of the Niagara Bridge. It should be remembered, that good cement grout, when not disturbed by any mechanical action or by a current of water, will set perfectly solid, and will become as hard as sand stone in course of time, and without shrinking. The anchor chains of the Niagara Bridge are, in my opinion, effectually guarded against oxidation.

But iron under certain conditions will undergo another change, which is not so well understood, and is indeed as yet a partial mystery. And this fact has been seized upon as an invincible argument against iron bridges generally, and against the Niagara Bridge especially. I refer to the supposed and popularly so-called *granulation* of fibrous wrought iron.

Although this subject has engaged my attention for a series of years, and I have taken pains to obtain correct information, I yet hesitate to express any decided opinions, that would cover the whole field of investigation. The question at large I consider open yet. This much only I believe to be settled, that good iron will undergo no change in course of time, unless it is acted on by great heat, or is under the influence of strong continuous vibrations under tension.

As an exception to this last proposition, may be cited the case of old anchors and chains, which, after being exposed on the ground or in the ground, a great length of time, had become considerably rusted and reduced in strength. Aside from rusting, magnetic influences were supposed to have been at work in destroying the strength of these irons. But it should be remarked, that none of these cases have been sufficiently well examined to warrant sound conclusions. It is true that the earth forms a great magnet, whose magnetism is maintained by the sun; and that the magnetic condition of all metals is more or less depending upon the great parent magnet. A steel magnet that has lost its power or tension, when buried in the earth, will be restored by its magnetic currents. But how far the cohesion and elasticity of wrought iron may be affected by these currents, we are yet ignorant of. When a bar of iron is drawn apart by a tensile strain, the fractured ends are magnetically excited, and will attract iron filings, at the same time that they become heated. Both phenomena, magnetism as well as heat, will always accompany the forcible rupture of iron, as can be readily ascertained by experiment. The same phenomena are also exhibited when iron is hammered cold, the heat in this case being more apparent than the magnetism.

The cohesion and elasticity of wrought iron, although different properties, appear to be closely related. In speaking of elasticity, I mean the natural elasticity, and not what is produced by the forced process of tempering. And here may be pointed out a marked physical difference between steel and iron. While the hardening or tempering of steel can be carried to almost any degree, that of the latter can not.

Whatever destroys or impairs the elasticity of iron or steel, will also affect its cohesion. And this fact has also a significant magnetic bearing. Tempered or hardened steel possesses more tensile strength than soft steel. Now when tempered steel loses its hardness by annealing, it assimilates nearer to soft iron in its relation to magnetism. Red-hot iron is not attracted by a magnet, while a steel magnet entirely loses its magnetic properties on being heated red hot. Another remarkable fact is, that artificial as well as natural magnets, when *overloaded*, become weakened. And so does the cohesion and elasticity of an iron or steel bar become weakened by overloading.

The limit of elasticity, or of the *recuperating* force, as it might be termed, of iron and steel is generally stated at one-third of their ultimate strength. I am of the opinion that this is much *over*-estimated for soft puddled irons, and *under*-estimated for good hammered charcoal irons, and still more for steel.

The force which holds together the molecules of iron, is termed cohesion. Heat will expand iron, and when applied intensely and continuously, will melt it, and will thus destroy all cohesion, and at the same time all elasticity and all magnetic tension. It follows, then, that heat of a certain degree is opposed to cohesion and elasticity. And this explains why large masses of wrought iron, when being forged, and thus subjected for a considerable length of time to an annealing process, will, in the centre, become greatly reduced in cohesion and elasticity. The previously existing fibre in the faggots will change into a coarse crystalline texture, because the iron being in a pasty and nearly molten state, and the mechanical effect of hammering being confined to the surface, and not penetrating to the centre, the formation of large crystals will be left undisturbed. Broken car-axles sometimes appear to have undergone a similar change. The fact is, that they generally exhibit a crystalline fracture. But I suspect that many new axles, although manufactured out of fibrous rough-bar, will, when finished and broken *before* they are used, also exhibit a crystalline fracture. In my own practice I have witnessed the fact, that an experienced manufacturer, anxious to satisfy me, did not succeed in manufacturing round bolt of four to five inches diameter out of good fibrous rough-bar, without producing a crystalline texture in the centre. The oftener he piled the iron, the worse the result. On the other hand, I never heard of a failure when the bolt was forged entire under the hammer, out of good and well worked and thoroughly hammered charcoal blooms, their rough ends cut off.

The most fibrous bar iron may be broken so as to present a granular and somewhat crystalline fracture, and this without undergoing any molecular change in the texture. Take a fibrous bar, say ten feet long, but the longer the better, nip it in the centre all around with a cold chisel, then poise the bar upon the short edge of a large anvil, and a short piece of iron, placed eight or nine inches from the edge on the face of the anvil, then strike a few heavy blows upon the nip, so that each blow will cause the bar to rebound, and to vibrate intensely, and the result will be a granular and somewhat crystalline fracture. Now take up the two halves, and nip them again all around, about one or two inches off the fractured ends, break them off by easy blows over the *round* edge of the anvil, and the fibre will appear again. This experiment proves that a break, caused by sudden jars and intense vibration, may show a granular and even crystalline fracture, without having changed the molecular arrangement of the iron. All fibres are composed of mineral crystals, drawn out and elongated or flattened; and the fracture may be produced so as to exhibit in the same bar, and within the same inch of bar, either more fibre or more crystal. But a coarse crystalline bar will, under no circumstances, exhibit fibre; nor will a well worked out fibre exhibit coarse crystals.

My own view of this matter is, that a molecular change, or so called *granulation* or *crystallization*, in consequence of vibration or tension, or both combined, has in no instance been satisfactorily proved or demonstrated by experiments.

I further insist that crystallization in iron or any other metal *can never take place in a cold state.* To form crystals at all, the metal must be in a highly heated or nearly a molten state.

On the other hand, I am witnessing the fact daily, that vibration and tension combined will greatly affect the strength of iron *without* changing its fibrous texture. The cohesion and elasticity of wire and wire rope will be rapidly destroyed by great tension and vibration combined. Whether I shall be able to account for it or not, *there stands the fact.* But what is true of iron wire applies with equal force, and, when all circumstances and conditions are duly proportioned, with even greater force, to larger masses. The extensive opportunities which my pursuits offer, to make experiments and observations on wire and wire rope, authorize a positive expression on this subject. A great deal of fancy speculation has been indulged in of late years on this question of granulation and crystallization, but generally by men whose opinion can have no weight.

Now, while the fact remains that iron and steel will lose their strength by vibration and tension, it is proper to state, also, in this connexion, that this loss of strength bears a due proportion to the extent and duration of the vibration and tension. Wire ropes may lose their strength by three months service, *without* exhibiting much wear; and they may also last ten years, running all the time, and be greatly worn, before their strength is so far reduced as to be unfit to do duty. I will state here, that there are now ropes of my manufacture on the inclines of the Morris Canal, which have run nine years. This great durability is owing to comparative absence of vibration, in consequence of slow speed and good machinery, although a high tension is maintained.

The greater the elasticity and cohesion of the iron or steel, the better it will support vibration and tension, always provided, that the extent of this vibration and the amount of tension are kept within safe limits. Witness, as examples, the durability of watch-springs, piano wire, sofa and wagon springs, &c., &c., &c.

Wrought iron that has become brittle, as, for instance, chain, car axles, wire or wire rope, on being annealed, will have its softness and apparently, also, its strength restored. As far as softness is concerned, this is correct; but in regard to strength, when applied to wire or wire rope or to fine chains, it is a mistake. Soft annealed wire possesses only half the strength which hard wire has, and is without any elasticity. But wire rope without elasticity is worthless; very little work will make it brittle again and worse than before. It is different with heavy chains and with car axles. Made of indifferent material, crystalline or brittle when new, they will be greatly improved by an annealing process at the very beginning; and if this process is repeated from time to time, their lifetime may be prolonged. I maintain that a good car-axle, made of good material, and finished at the proper heat, by hammering or rolling, is stiffer and stronger than the same axle, when again subjected to annealing without hammering or rolling. Annealing restores softness, but at the same time reduces cohesion and elasticity. To restore the iron of a brittle car axle fully, can only be done by a full heat, with hammering or rolling, which of course will reduce its diameter.

The opinion prevails, that a well drawn-out fibre is the only sure sign of tensile strength. This, however, is true only when applied to *ordinary* qualities of bar or rail iron. The fact is different with good charcoal irons and with steel. The greatest cohesion is accompanied by a fine, close-grained, uniform appearance of texture, which, under a magnifying glass, exhibits fibre. The color is a silvery lustre, free from dark specks. The finer and more close-grained the texture, the nearer the iron approaches to steel. Those who are familiar with good Swedish or Norway irons, will support these statements. These facts alone should be sufficient to disprove the erroneous notion that good iron and steel, which should always be granular, will become so only by vibration, and will thereby lose their strength. But it is important to keep in mind the distinction between a fine uniform granular fracture, and a coarse crystalline fracture. Where coarse crystallization appears, there is a want of contact and compactness, consequently of cohesion and strength generally.

Wire cables, car axles, piston rods, connecting rods, and all such pieces of machinery, which are exposed to great tension as well as torsion and vibration, should be manufactured of iron which not only possesses great cohesion, but also a high degree of hardness and elasticity. The best car axles now in use, are those made of soft steel by Krupf, in Germany. This steel is manufactured from the spathic ore or natural steel ore, of the celebrated mines at Muessen in Siegen, Prussia. A correct report on these axles was given to me by one of the Prussian Commissioners of Railways, in whose district Krupf's works are located. They are safe in cold weather and seldom known to break. This proves that soft steel with more of a granular texture than fibre, possesses a much greater elasticity and strength than the best fibrous iron; and it also furnishes another strong proof against the granulation theory, so much credited in this country.

It may be objected that steel is a different metal from iron. But all irons and steels are only so many different alloys of the same metal. There is no essential difference between the two. What constitutes the true chemical and physical difference between the two varieties, is not so clear. The old idea, that steel owes its distinguishing properties to a greater per centage of carbon alone, is no longer maintained. There are not two metallurgists who agree as to the proper per centage of carbon that good steel ought to contain. The ablest chemists who have analyzed iron and steel, from Karsten and Berzelius down to the present day, have not been able to give us a correct analysis of these two metals. Mr. Mushet, Jr., has recently shown that the excellence of steel is depending upon the presence of Titanium, a substance formerly overlooked. But so long as the chemistry of iron and of steel is still without a sure basis, we must fall back upon well discerned empyrical facts.

The capacity of irons to resist vibration and tension differs much in different qualities, and still greater is this difference when the irons are exposed to a very cold temperature. The tubular bridge at Montreal will not last as long as one in Great Britian of the same dimensions, material, and workmanship, and rendering the same service; and still less than the tubes over the Nile, in Egypt. One hard winter in Canada will be as trying to the structure as ten years are in Great Britain.

In order to examine the fitness of various qualities of iron for the manufacture of wire rope, I undertook, during the hard winter of 1856, at my establishment at Trenton, a series of experiments, when the thermometer was five to ten degrees below zero. The samples for testing, about one foot long, were reduced in the centre to exactly three-quarters of an inch square, and their ends left larger were welded to heavy eyes, making in all a bar of three feet long. Thus prepared, they were thrown outside of the mill, covered with snow and ice, and left exposed for several days and nights. Early in the morning, before the air grew warmer, a sample, inclosed in ice, would be put into the testing machine, and at once subjected to a strain of 26,000 lbs., the bar being suspended in a vertical position, left free all around. A stout mill-hand, armed with a billet of one-and-a-half inches in diameter and two feet long, then struck the sample horizontally a number of blows, hitting the reduced section, as hard as he could. The blows were counted and continued until rupture took place. Care was taken to maintain a tension of 26,000 lbs. during this test, by screwing up the lever, while the sample kept stretching. Other means for producing vibration were attempted, but none proved so effective as the hitting with an iron bolt. I would remark here, that most of these irons would support from 70,000 to 80,000 lbs. per square inch; and that good samples of three-quarters of an inch square, would support a strain of 26,000 lbs. for a whole week, with no visible stretching, provided all vibration and jarring was avoided. But the least jar would produce a permanent elongation.

Without going into the details of these interesting and instructive experiments, I will only state that the number of blows which the different samples resisted, when encased in ice, ranged from three to one hundred and twenty. Inferior qualities of a crystalline texture would break at the third or fourth blow. Good samples of refined puddled bar resisted very well, and went up to sixty blows, while the better qualities of hammered charcoal irons, supported up to one hundred and twenty blows, stretching and drawing all the time. Indeed, it seemed a wire-drawing process on a rough scale. On the tension being reduced to 20,000 lbs., some good samples resisted the almost incredible number of three hundred blows before breaking.

Such qualities of iron may be depended upon for the construction of wire cables and car-axles. They will be safe at the North Pole, while inferior qualities may answer very well in warmer latitudes.

Well observed facts of the durability of irons, when exposed to tension and vibration, are of more value than speculative opinions. I will here record a few more facts, experienced by myself.

In 1844 I removed the old timber aqueduct over the Allegheny river at Pittsburgh, the heaviest work of that description in the United States, consisting of seven spans of one hundred and fifty feet reach. It had stood fourteen years. All the suspension bars taken out of the old trusses and arches, and originally made of good puddled iron, on being tested and worked up into bolts for the new wire suspension aqueduct, proved of good quality, as good as such irons generally are.

During the great fire at Pittsburgh, in 1845, the old Monongahela bridge, of eight spans, a heavy Burr structure, burned down. I contracted to put up a suspension bridge, and accepted all the old materials, which were not consumed, including about thirty tons of hammered charcoal iron of excellent quality. This iron, after a severe usage for over thirty years, was found so good that I had it all drawn into wire. Every bar was good for 60,000 lbs. per square inch, as strong and tough as it ever could have been before going into the bridge. The old structure was loose and limber, producing considerable vibration on all vertical bars.

On excavating for the southern anchorage between the old wing-walls of the old Monongahela bridge, a number of round bars of one-and-a-quarter inches diameter, about 40 feet long, good puddled fibrous iron was taken up. They had served as tie bars to keep the retaining walls from spreading. Screwed up tight, they had been under ground about twenty-five years, embedded in clay. The outside rust, firmly combined with clay and sand, appeared to have formed a protective coat. At any rate the strength of the iron had not suffered at all from oxidation, its quality was as good as any puddled bar manufactured at the present day.

Last year, while removing the old St. Clair Street Bridge over the Allegheny River at Pittsburgh, to make room for a new Suspension Bridge, since completed, I examined the old iron with considerable interest and care. All this iron had been manufactured about forty-one years ago, and had been the result of the first attempts at puddling ever made west of the Allegheny Mountains. The manufacturer, who is still living, informed me that in those days puddling was not well understood, and that, although the stock was good cold blast charcoal pig, the iron turned out of a highly crystalline texture. It proved so on its fracture, but of a good color, the texture was uniform and not coarse. On being heated and drawn down to half its size, it made a strong fibrous iron; all it wanted was work. There was not one fibrons bar in the whole lot of suspension bars; they were all alike crystalline and brittle in texture. This iron had, from the manufacturer's own testimony, undergone no change; it was as crystalline on the last day as it was on the first. But there was another quality of iron in the same structure. The straps and bolts which connected the chords with the posts and braces, had been manufactured of a good quality of hammered charcoal iron, and a most capital iron it proved after forty years service.

I will also draw attention to those interesting experiments made recently by Mr. Albert Fink, on a number of suspension bars, taken out of his bridges on the Baltimore and Ohio Railroad, for the purpose of testing their strength after seven years service. These tests exhibited a rate of strength which is only possessed by good iron, and led Mr. Fink to the conclusion that seven years wear had not affected the bars.

All irons form alloys of pure iron, mixed with carbon and other impurities. A certain amount of impurities in the shape of good cinder appears to be necessary to impart strength and cohesion to this metal, and also to make it malleable, and to give it welding properties. The purer the iron is, the higher the heat at which it will weld. Compare, for instance, good Swedish iron with common puddled bar. While the latter will weld at a low heat, the former requires a much higher heat. Compare their fracture and color. The good Swedish bar will exhibit either a fine granular appearance or fibre, accompanied by a silvery lustre, showing comparative purity; the puddled bar will be of a dark color, with a graphite lustre, and will show a coarse texture or loose fibre.

During the process of puddling, as well as of blooming, the melted pig-iron is mixed with cinder, and this mixture, which will adhere by cohesion, prevents the formation of large crystals, which is the tendency of pure iron in a molten state. Now by working (bringing to *nature*, as the puddler calls it), this mixing and crystallization is promoted. The subsequent squeezing and rolling of the puddled ball, or the hammering and shingling of the bloom, will have the effect of condensing, laminating, reducing, and drawing out these crystals, at the same time removing and squeezing out the superabundant cinder from between the metallic crystals. Thus the drawn-out fibre is composed of an aggregate of pure iron threads and leaves, enveloped in cinder.

Pure iron as well as very impure iron is weak; the maximum strength and toughness is obtained by a certain mixture of pure iron with carbon and cinder, thoroughly worked and incorporated. When the fibrous and laminar aggregation becomes so dense as to be fit for the manufacture of steel, then are by this very process sufficient impurities expelled, and the greatest degree of cohesion is obtained. Hence strong steel can only be made of strong iron, no matter what chemicals may be administered during the process.

Keeping the above process before our mind, we may now understand why even the best fibrous wrought iron, when exposed to long continued vibration under tension, or to torsion, bending or twisting, must inevitably become brittle, *because the iron threads and laminæ become loosened in their cinder envelopes.* But the cohesion between the iron and its cinder once destroyed, and its strength is gone. Now whether cohesion is the result of magnetic attraction (according to Faraday) or otherwise, this process appears to be purely mechanical. But let the explanation, which is here offered, be correct or not, the fact remains that fibrous iron and all kinds of iron and steel, will be rendered brittle by vibration and tension, or by bending and twisting, *without* undergoing any mysterious change in its molecular arrangement.

It is only within the last one hundred years that wrought iron has become a *necessity* on public and private works. Large structures entirely composed of iron are of a still more recent date. Long experience on a large scale is therefore wanting. But as far as it goes, the opinion is fully sustained, that good iron, not overtaxed by tension and vibration, and otherwise preserved, will prove one of the most durable building materials at our disposal.

The Menai Chain Suspension Bridge, has now stood about thirty-six years, and is still considered a safe work, although it has, for the want of stiffness, on several occasions suffered severely from gales. The old Wire Suspension Bridge, at Friburg, in Switzerland, has been in use about twenty-seven years, but it does not possess enough of strength and stiffness to guarantee its safety much longer in its present state.

It should be remembered that there are many suspension bridges in this country, as well as in Europe, built without any regard to stiffness, and are therefore constantly subjected to vibration, which must greatly limit their durability.

The cables of the Niagara Bridge, on the other hand, are free from vibration, consequently will last as long as the nature of good wrought iron will permit, when subjected to a moderate tension, not exceeding one-fifth of its ultimate strength. This durability I am unwilling to estimate at less than several hundred years.

Iron has emphatically become *the material of the age.* Upon its proper use the future comfort and physical advancement of the human race will principally depend. It will yet be the harbinger of peace, as already it has given us the means of locomotion and of intelligent intercourse. The subject of this paper is therefore of great importance and is entitled to a truthful consideration.

I will close this report by repeating once more, that the cables of the Niagara Bridge are made of a superior quality of material; that they possess an abundance of strength; that they are free from vibration; that they are well preserved and taken care of; and consequently that they may safely be trusted for a long series of years.

Trenton, N. J., August 1, 1860.

*Water Cisterns in Venice.**

The French Academy of Sciences has received a communication from M. G. Grimaud, on the manner in which the Venetians construct their cisterns, a plan which he thinks might be advantageously introduced on the heights which overlook Paris, and are occupied by large establishments and a numerous population, and which would greatly benefit by them. Venice occupies a surface of 5,200,000 square metres (1300 acres), exclusive of all the great and small canals which intersect it. The annual average of rain is 31 inches, the greater part of which is collected in 2077 cisterns, 177 of which are public. The rain is sufficiently abundant to fill the cisterns five times in the course of the year, so that the distribution of water is at the rate of 16 litres ($3\frac{1}{2}$ gallons) per head. To construct a cistern after the Venetian fashion, a large hole is dug in the ground to the depth of about 9 feet, the infiltration of the lagoons preventing their going any deeper. The sides of the excavation are supported by a frame-work made of good oak timber, and the cistern thus has the appearance of a square truncated pyramid with the wider base turned upwards. A coating of pure and compact clay, 1 foot thick, is now applied on the wooden frame with great care; this opposes an invincible obstacle to the progress of the roots of any plants growing in the vicinity, and also to the pressure of the water in contact with it. No crevices are left which might allow the air to penetrate. This preliminary work being done, a large circular stone, partly hollowed out like the bottom of a kettle, is deposited in the pyramid with the cavity upwards; and on this foundation a cylinder of well baked bricks is constructed, having no interstices whatever, except a number of conical holes in the bottom row. The large vacant space remaining between the sides of the pyramid and cylinder is filled with well scoured sea sand. At the four corners of the pyramid, they place a kind of stone trough covered with a stone lid pierced with holes. These troughs communicate with each other by means of a small rill, made of bricks, and resting on the sand, and the whole is then paved over. The rain water coming from the roofs runs into the troughs, penetrates into the sand through the rills, and is thus filtered into the cylinder or well-hole by the conical holes already described. The water thus supplied is perfectly limpid, sweet, and cool.

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* From the Journal of the Society of Arts, No. 405.

*A Subway in London.**

The Metropolitan Board of Works report that, with a view to the adoption of means for obviating the expense and inconvenience attending the breaking up of the pavement for the repair of mains and pipes, sewers, and other underground works, and in the hope of obtaining valuable data for their guidance in carrying out future improvements, they determined in making the New Covent-garden approach to form a subway under the street for the reception of gas and water mains, electric telegraph conductors, &c.; and on the 31st of July they entered into a contract for the execution of these works, and they are now in hand. They propose to construct under the street an arched subway 7 feet 6 inches in height by 12 feet in width, and also to form arched side passages for house service pipes, together with proper cellarage on each side of the street. In conjunction with the works proper sewers will be built, and convenient arrangements made for drainage.

* From the Lond. Civ. Eng. and Arch. Journal, Oct., 1860.

*Strength of Building Stones.**

The following table (showing the specific gravity of colonial and other building stones, the force required to crush one-inch cubes, the amount of disintegration caused by the action of sulphate of soda, taking 1000 as an indication of perfect resistance, and the weight per cubic foot) is from Mr. Knight's treatise mentioned in our notice of the Melbourne Houses of Parliament:

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*From the London Builder, No. 918.

	Specific gravity.	Crushing force per square inch.	Am't of disintegration.	Weight per cubic foot in an ordinary state.	Weight per cubic foot after four hours' immersion in water.
COLONIAL STONES.		In lbs.		In lbs.	In lbs.
Darley sandstone, .	2350	2118	·800	124 7-16	132
Bacchus Marsh sandstone,	2213	1949	·200	124	133 5-16
Geelong sandstone, .	2207	2150	·600	136 11-16	138 10-16
Kyneton sandstone, :	2250	—	·600	131 7-16	135 11-16
Kilmore sandstone, .	2423	3100	·650	——	——
Bulleen sandstone, .	2484	2100	·750	142 9-16	147 4-16
Doncaster sandstone, :	2487	3163	·800	——	150
Plenty sandstone, .	2455	3200	·500	146 13-16	150 3-16
Portland (western district) limestone, .	2503	3065	·700	——	——
Warrnambool limestone. a picked specimen, hardened by salt water, .	2438	5035	·800	——	——
Cape Schank limestone,	2500	3550	·600	——	146
Ballan sandstone, .	2446	2450	·800	——	——
Keilor sandstone, .	2477	1600	·300	145 11-16	149 10-16
Western Port sandstone, .	2357	5400	·500	148 8-16	149 5-16
Apollo Bay sandstone,	2473	Tested up to 6720 lbs. without producing any effect. The machine was inadequate to go beyond this weight.	1·000	——	——
Bluestone (basalt), .	2625		—	——	163 7-16
Granite from the Plenty,	2655		1·000	——	——
Sienite from Gabo Island, .	2652		1·000	——	——
Templestowe clay slatestone,	2600		1·000	——	——
Mount Sturgeon sandstone,	2386		1·000	142 12-16	144
INTER-COLONIAL STONES.					
Pitfield's New Kangaroo Point sandstone from Tasmania, .	2207	2956	·900	132 3-16	134 9-16
Kangaroo Point stone, old quarry,	2252	2881	·050	135 5-16	137 2-16
North-west Bay sandstone from Quinn's quarry, Tasmania, .	2322	2089	·700	140 9-16	143
Huon River sandstone, Tasmania,	2417	—	·001	——	——
Sydney sandstone, .	2237	2228	·300	——	——
Adelaide sandstone, .	—	2800	—	——	——
Adelaide marble, .	2715	Tested up to 6720 lbs. without effect.	1·000	——	167 5-16
STONES FROM EUROPE.					
Fifeshire sandstones, Scotland,	—	1814	·100	128 3-16	136
Bath oolite, England, .	2241	1600	·800	124 14-16	126 6-16
Portland oolite, England,	2447	3135	·950	137 2-16	140 9-16
Park Spring sandstone, from near Leeds, G. B., .	2383	Tested up to 6720 lbs. without producing any effect.	1·000	——	148
Caen, Normandy, .	2076	1543	·700	134 5-16	136 4-16
Carara marble, :	2713	Tested up to 6720 lbs. without producing and effect.	1·000	166	——

TABLE *showing the Weight required to crush inch cubes of the four Building Stones principally used in Melbourne.*

	Crushing force per square inch when dry.	Crushing force per square inch after four hours immersion in water.	
	In lbs.	In lbs.	
Pitfield's new quarry at Kangaroo Point, ...	2956	1919	$31\frac{2}{3}$
Pitfield's old quarry at Kangaroo Point, ...	2881	1428	$50\frac{1}{2}$
Darley, ...	2118	1260	$35\frac{1}{3}$
Bacchus Marsh, ...	1949	1073	45

The above results are derived from the average of four samples of each stone in a dry and two of each in a wet state.

Experiments to prove the fitness of the following stones to act as lintels, &c., tried on scantlings 4 by 4 inches, having a span of 4 feet, and the entire weight suspended from the centre:

	Breaking Weight.		
	cwt.	qrs.	lbs.
Fifeshire, Scotland, sandstone,	1	1	26
Bath oolite, English,	2	2	20
Kangaroo Point white sandstone, from Pitfield's new quarry, Tasmania.	2	2	20
Kyneton, Victoria, sandstone,	2	2	21
Kangaroo Point sandstone, Pitfield's old quarry,	2	3	20
Bacchus Marsh sandstone, Victoria,	2	3	24
Darley sandstone, Victoria,	3	0	2
Bulleen sandstone, Victoria,	3	2	0
Doncaster sandstone, near Bulleen,	3	3	20
Geelong, Barrabool Hill sandstone,	4	2	20
Portland limestone, English,	6	0	20
Park Spring sandstone, from England, near Leeds,	9	3	6
Adelaide marble,	10	1	11
Colonial basalt,	13	0	2
Mount Moriar, near Geelong,	4	3	15

For the Journal of the Franklin Institute.

Description of a New Portable Coffer Dam. By Capt. E. B. Hunt, Corps of Engineers, U. S. A.

[Read before the American Association of Science, at Newport, R. I., August, 1860.]

The use of the coffer dam in laying foundations under water, is among the best established and most reliable resources of the engineering profession, and its application in several classes of cases is well settled. In making studies for certain contemplated constructions at Fort Taylor, Key West, a new style of coffer occurred to me, which I hope soon to apply and which gives rational promise of success.

The first case considered was one of founding wharf and bridge piers on a rock bottom, over which a thin stratum of sand is spread. A set of piers, ten feet square, of solid masonry from the bottom, was first contemplated. For these the style of coffer planned was a strong square frame, with four corner posts, and a sufficient number of wale-courses across the four sides, and framed into these corner posts, to give the stiffness of side-wall necessary for supporting the whole water-pressure. The length of the corner pieces would be such as to give an excess of a foot or more at the top in the deepest water at high tide. The size in plan would have to be such as to give the requisite working space, and might be reduced to fifteen feet square. This frame work being put together, and stayed by a set of diagonal rope tie braces, could be launched and taken to its position, where it would be placed erect and adjusted to be level, using, if necessary, uprights in one or more angles, to bear on the bottom, or to be driven to the rock, and then lashed or bolted to the leveled frame. These angle posts can be sufficiently driven to give security against the force of tides and currents when needed, and also to sustain the weights required to be rested on the top of the frame. The coffer frame being thus fixed in position, a row of sheet piling of sound, three-inch, hard pine plank remains to be driven to the rock, in contact with the wales, and guided either by two outside timber guides, made to be removable, or by fixed, flat, iron bar guides with the angles smoothed.

Now comes the feature which I suppose to be entirely novel, and which gives a peculiar character to this portable coffer dam. Take strong canvass, and proceed to make up a case or covering for the entire coffer, using two thicknesses of canvass, and interposing a complete coating of mineral or coal tar, so as not only to cause the two canvass layers to adhere to each other thoroughly, but to make a perfectly impervious sheathing. Along the bottom edge of the coffer sheathing, a similar double canvass flap is joined around the whole bottom line, which will lay spread out over the bottom as far as is judged necessary. This breadth of flap will depend essentially on the nature of the bottom. The surface to be thus covered should first be raked clear of sticks, stones, &c., to prevent tearing holes through the flap. The case and flap, water-tight through their whole extent, and having much positive strength to resist pressure, being put on the coffer and surrounding bottom, it only remains to proceed with the pumping, which being actively pushed will rapidly reduce the small enclosed water column. As this goes on, the exterior pressure comes first on the canvass coating, and this in turn rests against the sheeting piles and along the entire surface of the bottom. As the sheeting should be of even thickness with straight edges, the joints will be close and narrow; hence there will be no danger of ruptures from the bridging strain across them. The submerged exterior guides being either removed or formed of iron bars with beveled edges, would create no dangerous strains. To bring the flap more closely to the bottom, a sprinkling of sand or any clean earth might be thrown over it when in place, or the outer edge might be weighted if needful. In case the water should penetrate through the bottom covering layer, even from the outer boundary of the flap, it is only required to scoop out the enclosed sand, and fill in the bottom with a layer of concrete, as is usual in the common coffer, using the *tramis*, a plain wooden trough, or a box with a trip bottom.

It only remains to proceed in building the piers, using the top of the coffer as a platform, and to support the derrick or traveler, the materials being lightered alongside. Should a steam pump be found necessary, this could be worked on board a lighter, by using a flexible pipe, led through the side at the top, or it could be carried through the case and sheathing near the bottom. A series of lashings along the top of the case could be used for fastening it, and buoyed cords attached to the edge of the flap would serve for its manœuvre.

Another mode of treating this case might be preferred for great depths. This is by using a circular coffer made by trimming to the required arc sweeps of three-inch planks, combining them in full circle ribs so as to break joints and fastening with screw bolts. This is merely turning an arch centre into the vertical. Launching one rib, a set of upright struts with draw-bolts would be placed on it, and the second rib built on them, &c. In some cases this might be superior to the square coffer. The modification of the case and flap would offer no serious difficulty. Various other timber and iron coffer frames might be advantageously used in treating this case.

In the instance first considered, it was desirable not to obstruct the water-way more than was necessary to get the solidity required by a permanent wharf for heavy vessels. A series of these piers giving the requisite supports for the wharf and bridge platforms answered these conditions, and it was supposed that this plan could be used in water of over twenty feet.

The facility with which this portable coffer can be struck and established is its great recommendation. Admit the water, hoist the case, draw the sheeting, and float the frame to its next station, buoying, if necessary, and then all becomes simple repetition. It is a question of judgment or calculation in each case to give the frame-work the stability required for resisting the pressures, currents, and wave actions; as also to decide where the probable violence of waves would make the plan impracticable or injudicious. Judgment must also be used in deciding whether the ruggedness of the bottom makes this plan inapplicable. Sometimes this difficulty would be fully met by throwing around the coffer a covering sheet of fine clay or marl, which will either make the bottom tight, or so cushion it that the flap can be used successfully. When we contrast the simplicity of this coffer and the facility with which it can be established and transferred, with the complex character of the ordinary fixed coffers, or with Stevenson's portable coffer, so limited, comparatively, in its applications and troublesome in erection, it will need but little consideration to perceive the utility of this device in numerous cases of bridge piers and other structures. To extend the above system to larger piers requires only the application of simple well established principles, which every competent engineer would easily make, and which need not be here dwelt upon.

It is likely to find its first application in a sea wall, which will probably be built at Fort Taylor next winter. It is proposed to use in this case a portable coffer of 50 by 12 feet in five compartments of framing, the intermediate submerged cross bars being made movable. The building of the first section of wall will not much differ from the building of a pier, except that the masonry bond at each end must be arranged to provide for the adjoining sections. In walls but little exposed to the sea, the sections can be brought above low water independently by building plain heads and leaving a clear joint. Of course this would not do where the foundation is bad and the load irregular.

To build this second section, the coffer would be re-established as before, except that the end should be arranged to embrace the wall already carried up, and the sheeting should be shaped to close in neatly on its front and rear faces. The case and flap will have to be so altered at this end as to fit the section of the wall, and extend along its front and rear faces for some distance. In the proposed wall, the use of dovetailed header and stretcher courses of granite is contemplated for the face, and a massive concrete filling for the back. The box planking for the concrete can rest against the main uprights and can be recovered on striking, thus leaving all the spare space in the coffer for face work.

The simplicity of this coffer and the facility with which it can be shifted from section to section of a sea wall, lead me to believe that it will be found a great source of economy in constructing the walls of wharves, basins, docks, &c., when the shelter from waves and the character of bottom make it available. In many cases the flap could be nearly omitted, and in some rough bottoms the simple coffer case could be used and a slight foot slope of puddle or earth, which works tight, could be thrown in so as to serve the purpose.

This device not having yet been tried, I should scarcely bring it before the public, except that I am willing by publication at once to prevent patents and to give to engineers the benefits it offers, which can be seen beforehand with almost absolute certainty.

For the Journal of the Franklin Institute.

Expansion of Steam.

At a late meeting of the American Engineers' Association, New York City, the subjoined paper was read by its author, Mr. Louis Koch, Mechanical Engineer. E. B.

New York, Nov. 14, 1860.

QUESTION.—*What is the pressure of steam in the cylinder at the end of the stroke when cut off at half stroke?*

This question is easily answered by the experimental tables laid down by the Committees of the French and the Franklin Institutes, by Dr. Lardner, and many others, showing the total pressure in pounds, the corresponding temperature, the volume of steam compared to the volume of water that has produced it, and the mechanical effect of a cubic inch of water evaporated in pounds raised one foot; all of which show conclusively that the pressure of steam in the cylinder at the end of the stroke, when cut off at half stroke, is *not* one-half of its full pressure, and that this difference becomes greater, first, with the increase of pressure, and, secondly, with the decrease of cutting off; all this is strictly theoretical, without regard to friction or the influence of the atmospheric pressure.

The following are a few examples taken from Dr. Lardner's table:

Volume of Steam.	Temperature.	Pressure.	Double Volume.	Corresponding Pressure.	Difference.
1281	228·5	20 lbs.	2562	about 9½ lbs.	½ lbs.
2426	192·4	10 "			
679	269·1	40 "	1358	19·2 "	·98 "
1281	228·5	20 "			
470	295·6	60 "	940	28·03 "	1·97 "
883	251·6	30 "			
362	315·8	80 "	724	37·3 "	2·97 "
679	269·1	40 "			
295	332·0	100 "	590	46·34 "	3·36 "
554	283·2	50 "			

There can be no doubt of the existence of a fixed relation between the temperature and pressure of steam by immediate evaporation when it has received no heat except that which it takes from the water, but that relation is not known, and, therefore, empyrical formulæ have been proposed, which express, with more or less precision, this relation in different parts of the thermometrical scale.

Mr. Southern proposes the annexed, when the pressure does not exceed one atmosphere:—

$$\mathrm{P} = 0{\cdot}04948 + \left(\frac{51{\cdot}3 + \mathrm{T}}{155{\cdot}7256}\right)^{5{\cdot}13}$$

$$\mathrm{T} = 155{\cdot}7256 \times \sqrt{\mathrm{P} - 0{\cdot}04948} - 51{\cdot}3$$

Tredgold proposes, when the pressure is from one to four atmospheres:—

$$\mathrm{P} = \left(\frac{103 + \mathrm{T}}{201{\cdot}18}\right)^{6} \qquad \mathrm{T} = 201{\cdot}18 \sqrt[6]{\mathrm{P}} - 103$$

Dulong and Arago propose, when the pressure is from four to fifty atmospheres:—

$$\mathrm{P} = (0{\cdot}26793 + 0{\cdot}0067585\ \mathrm{T})^{5} \qquad \mathrm{T} = 147{\cdot}961 \sqrt{\mathrm{P}} - 39{\cdot}644.$$

Other formulæ are given by Biot, Taylor, Gay Lussac, &c.

The same uncertainty exists in the relation between the pressure and the augmented volume, and recourse has also been had to empyrical formulæ, of which two, as the most convenient for low pressure engines of every form as well as for high pressure engines on the expansion principle, are given.

Dr. Lardner proposes

$$\mathrm{V} = \frac{3875969}{164 + \mathrm{P}'}. \quad \mathrm{V} = \text{volume per number of cubic inches.}$$

A more accurate formula, when not less than 30 lbs. per square inch is used, is the following:—

$$\mathrm{V} = \frac{4347826}{618 + \mathrm{P}'}. \quad \mathrm{P} = 1 \text{ lb. per square foot.}$$

It is well to remark here, in relation to temperature, upon the well known fact that the sum of the sensible and latent heats is a constant quantity; if water at 32° temperature is converted into steam under a pressure of one atmosphere, or 14¾ lbs. per square inch, it is necessary to give it first 180° additional sensible heat, and afterwards 990° of latent heat, making a total of 1170° of imparted heat and 32° of contained heat, or 1202° in all. Should the pressure be two atmospheres, the sensible heat would be augmented to 250°, and the latent heat decreased to 952°; at three atmospheres, respectively 275¼° and 926¾°, and thus continuing, the sensible augmenting and the latent diminishing, as the pressure increases, the constant total being 1202° F., 1170° of which are necessary for the evaporation of ice-cold water, which, consequently, would be raised to the temperature of 1202° if evaporation was prevented.

A very easy mode of calculating the volume of steam under higher temperature than that of one atmosphere is the following:—

1. It being known that air expands with every degree Centigrade, to 1-270ths of its primitive volume at 0° C., it follows that 270 cubic feet of air when heated from 0° to 100° C., will expand to 370 cubic feet, and that 1 cubic foot of air of 100° C. heated with further (t) degrees will become

$$\frac{370+t}{370} \text{ cubic feet.}$$

2. It being known that steam expands agreeably to the same law, it follows that steam of 100° C. if its temperature is increased 21·4° C. will increase to

$$\frac{370+21{\cdot}4^\circ}{370}=\frac{391{\cdot}4}{370} \text{ cubic feet;}$$

therefore, steam from 1 lb. of water, or 1691 cubic feet, will have a volume of

$$\frac{391{\cdot}4}{370}\times1691=1789{\cdot}078 \text{ cubic feet.}$$

3. And as it is, lastly, known that at the same temperature, the pressure of elastic fluids is proportionate to its density, and as saturated steam at 121·4° C. has just double the pressure (or that of two atmospheres), it follows that the before mentioned 1789·078 cubic feet must have double the density, and, therefore, a volume of 894·539 cubic feet.

Having now conclusively proved that the volume of steam increases with the pressure, it follows that there is a decrease of volume with the decrease of pressure, and it is, therefore, evident that the mechanical effect of steam when cut off at any part of the stroke will not be fully one-half of that of its expansion; all this is nothing new, as many tables have been laid down to this effect, as noted above, but as a basis for further calculations on the advantage or disadvantage of cut-offs generally they are valuable.

Now, let us see if there is an advantage in practice by cutting-off steam at any part of the stroke. We will select a bore of cylinder of 200 inches area, or about 16 inches in diameter and 6 feet stroke. We have, at first, to contend with friction and atmospheric pressure at the exhaust; the first of these (friction) is the most difficult to find a basis for, but it being generally conceded that 2½ lbs. per square inch is sufficient in a well built engine, we will take that as a standard.

The atmospheric pressure at the exhaust is the same in both cases, and in relation to the quantity to be discharged, what is less in one case is made up by velocity in the other. It is to be remarked that when, according to the indicator, we work under 50 lbs. pressure, we actually have 64¾ lbs. on the piston (theoretically), the difference of pressure in the boiler and that exerted upon the piston, we will omit, being in both the same, if any, as has been asserted. Let us take 60 lbs. total pressure on the piston, and then find the mechanical effect in following full stroke and cutting-off at one-half, one-third, and one-quarter stroke.

The mechanical effect of full stroke will be 60 lbs. per square inch, or 12,000 lbs. per 200 square inches, or .	72,000 lbs. lifted 1 ft.
Deducting for friction $2\frac{1}{2}$ lbs. per square inch equals 500 lbs., or 3000 lbs. lifted one foot, and atmospheric pressure $14\frac{3}{4}$ lbs. per square inch equals 2950 lbs., or 17,700 lbs. lifted one foot . . . =	20,700 " "
and there remains a clear effect of	51,300 lbs. or $71\frac{1}{4}$ per c.

It has often been asserted that 85, 90, and 95 per cent. mechanical effect has been obtained, but this is decidedly an error, as the pressure was calculated agreeably to the indicator; the indicator in this case would only show $45\frac{1}{4}$ lbs. at 200 square inches equals 9000 lbs., or 54,300 lbs. lifted one foot, thus presenting a mechanical effect of nearly $94\frac{1}{2}$ per cent., which is a deception.

The mechanical effect of cutting-off at one-half stroke will be 60 lbs. per square inch or 12,000 lbs. per 200 square inches; 3 feet stroke equals 36,000 lbs. lifted one foot; at the end of the stroke, as has been seen, we have 28·03 lbs. pressure, and, therefore, a mean pressure of 44·015 lbs. per square inch, or 8803 lbs. per 200 square inches; 3 feet stroke equals 26,409 lbs. lifted one foot; adding as above, we have 36,000+26,409 lbs.=62,409 lbs. lifted one foot. Deducting the foregoing friction and atmospheric pressure, 20,700 lbs. lifted one foot, and there remains a clear mechanical effect of 41,709 lbs. lifted one foot, or 57·93 per cent., with half the amount of steam, or 83,418 lbs. lifted one foot, with full steam, being nearly 116 per cent. (115·86 per cent.)

The mechanical effect of one-third stroke will be 60 lbs. per square inch, or 12,000 lbs. per 200 square inches; 2 feet stroke =24,000 lbs. lifted one foot; we have, as seen at the end of the stroke, 19·2 lbs. pressure, and, therefore, a mean pressure of 39·6 lbs. per square inch, or 7920 lbs. per 200 square inches; 4 feet stroke equals 31,680 lbs. lifted one foot; adding as above, we have 24,000+31,680=55,680 lbs. lifted one foot. Deducting friction and atmospheric pressure 20,700 lbs. lifted one foot, and there remains a clear effect of 34,980 lbs. lifted 1 foot, or $48{\cdot}53\frac{1}{3}$ per cent, with one-third the amount of steam, or 104,940 lbs. lifted one foot, with full steam, being $145\frac{3}{4}$ per cent.

The mechanical effect of one-quarter stroke will be 60 lbs. per square inch, or 12,000 lbs. per 200 square inches; $1\frac{1}{2}$ feet stroke = 18,000 lbs. lifted one foot; at the end of the stroke, we will have 13·19 lbs. pressure, or a mean pressure of 36·595 lbs. per square inch, or 7319 lbs. per 200 square inches; $4\frac{1}{2}$ feet stroke = 32,935·5 lbs. lifted one foot; adding as above, we have 18,000 + 32,935·5 = 50,935·5 lbs. lifted one foot. Deducting friction and atmospheric pressure, 20,700 lbs. lifted one foot, and there remains a clear effect of 30,235·5 lbs. lifted one foot, or nearly 42 per cent., with one-quarter the amount of steam; or 120,942·0 lbs. lifted one foot, with full steam, being 168 per cent.

Again; let us see if the same proportions exist in a smaller cylinder, shorter stroke, and the same pressure; we will select an area of 50 ins., or about 8 ins. in diameter, 4 ft. stroke, and 60 lbs. pressure.

1st. The mechanical effect of full stroke will be 60 lbs. per square inch, or 3000 lbs. per 50 square inches: 4 feet stroke . = 12,000 lbs. lifted one foot.
Deducting for friction 2½ lbs. per square inch = 125 lbs.,
or 500 lbs. one foot, and atmospheric pressure 14¾ lbs. per
square inch = 737·5 lbs., or 2950 lifted one foot = 3,450 “ “

And there remains a clear effect of . 8,550 “ “
or 71¼ per cent.

2d. The mechanical effect of cutting off at half stroke, will be 60 lbs. per square inch, 3000 lbs per 50 square inches: 2 feet stroke = 6,000 lbs. lifted one foot.
44·015 lbs. mean pressure per square inch, or 2200¾ lbs.
per 50 square inches: 2 feet stroke . . = 4,401½ “ “

Adding, we have . . 10,401½ “ “
Deducting friction and atmospheric pressure . = 3,450 “ “

And there remains a clear effect of . 6,951½ “ “
or 57·93 per cent. with half the amount of steam, and 13,903 lbs. lifted one foot, or 115·86 per cent. with full steam.

3d. The mechanical effect of cutting off at one-third stroke will be 60 lbs. per square inch, 3000 lbs. per 50 square inches: 1⅓ feet stroke = 4000 lbs. lifted one foot.
39·6 lbs mean pressure per square inch, or 1980 lbs. per
50 square inches: 2⅔ feet stroke . = 5280 “ “

Adding, we have . . 9280 “ “
Deducting friction and atmospheric pressure = 3450 “ “

And there remains a clear effect of . 5830 “ “
or 48·58⅓ per cent. with one-third the amount of steam, and 17,490 lbs. lifted one foot, or 145¾ per cent. with full steam.

4th. The mechanical effect of cutting off at one-quarter stroke will be 60 lbs. per square inch, or 3000 lbs. per 50 square inches: 1 foot stroke = 3000 lbs. lifted one foot.
36·595 lbs. mean pressure per square inch, or 1829¾ lbs.
per 50 square inches: 3 feet stroke . = 5489¼ “ “

Adding, we have . . 8489¼ “ “
Deducting friction and atmospheric pressure = 3450 “ “

And there remains a clear effect of . 5039¼ “ “
or nearly 42 per cent. with one-quarter the amount of steam, and 20,157 lbs. lifted one foot, or 168 per cent. with full steam.

It only remains to investigate, if under a different pressure the relations will be the same: we will, therefore, take the same cylinders and strokes, with a pressure of 36 lbs.

1st. The mechanical effect of full stroke will be 36 lbs. per square inch, or 7200 lbs. per 200 square inches: 6 feet stroke . = 43,200 lbs. lifted one foot.
Deducting for friction 2½ lbs. per square inch = 500 lbs.,
or 3000 lbs. lifted one foot, and atmospheric pressure 14¾ lbs.
per square inch = 2950 lbs., or 17,700 lbs. lifted one foot = 20,700 “ “

Leaving a clear effect of . 22,500 “ “
or 52·083 per cent.

2d. The mechanical effect of cutting off at one-half stroke will be 36 lbs. per square inch, or 7200 lbs. per 200 square inches: 3 feet stroke = 21,600 lbs. lifted one foot.
26·513 lbs. mean pressure per square inch, or 5302·6
per 200 square inches: 3 feet stroke . = 15,907·8 “ “

Adding, we have . . 37,507·8 “ “
Deducting friction and atmospheric pressure = 20,700·0 “ “

Leaving a clear effect of . 16,807·8 “ “
or 38·905 per cent. with one-half the amount of steam, and 33,615·6 lbs. lifted one foot, or 77·810 per cent. with full steam.

3d. The mechanical effect of cutting off at one-third stroke will be 36 lbs. per square inch, or 7200 lbs. per 200 square inches: 2 feet stroke . = 14,400 lbs. lifted one foot.
23·48 lbs. mean pressure per square inch, or 4696 lbs. per 200 square inches: 4 feet stroke . = 18,784 " "
Adding, we have . . 33,184 " "
Deducting friction and atmospheric pressure = 20,700 " "
Leaving a clear effect of . 12,484 " "
or 28·9 per cent. with one-third the amount of steam, and 37,452 lbs. lifted one foot, or 86·7 per cent. with full steam.

4th. The mechanical effect of cutting off at one-quarter stroke will be 36 lbs. per square inch, or 7200 lbs per 200 square inches: 1½ feet stroke . . . = 10,800 lbs. lifted one foot.
22·0178 lbs. mean pressure per square inch, or 4403·56 lbs. per 200 square inches: 4½ feet stroke . = 19,816 " "
Adding, we have . . 30,616 " "
Deducting friction and atmospheric pressure . = 20,700 " "
Leaving a clear effect of . . 9,916 " "
or 22·95 per cent with one-quarter the amount of steam, and 39,664 lbs. lifted one foot, or 91·81 per cent. with full steam.

The same per centage exists under the same pressure, whatever the diameter of the cylinder or length of the stroke may be.

In the foregoing calculations, condensation in the cylinder has not been taken into consideration; it will, of course, be greater in proportion to the cut-off being smaller, but the difference to me seems to be trifling, and will cause but little alteration in the above calculations of per centage.

And now, having arrived at a point from which we are enabled to deduce certain elements, the subjoined are submitted:—

1st. The pressure of steam in the cylinder at the end of the stroke, when cut off at any point during the stroke, is smaller than the proportion to the full pressure; and this difference becomes greater, first, with the increase of pressure, and secondly, with the decrease of cutting off.

2d. The per centage of mechanical effect between that of full stroke and that of cutting off at any point of the stroke, remains the same, the cylinder being large or small, the stroke long or short, as long as the pressure is the same.

3d. The greater the pressure the greater the per centage of mechanical effect in high pressure engines, under all circumstances. (The relations seem to be different in low pressure engines, which I propose to discuss at a future time.)

4th. The greater the pressure, the greater the relative per centage between the full stroke and the cut-off system.

5th. There is no such thing as a greater mechanical effect in the same cylinder and at the same pressure, when cut-offs are used instead of full steam during the whole stroke; but, on the contrary, there is a proportionate and not inconsiderable falling off of mechanical effect when the former is used, notwithstanding all that has been or may be said to the contrary, and this difference becomes greater with a lesser pressure.

6th. The same amount of steam, under the same pressure, in the same cylinder, used with cut-offs instead of following full stroke, will produce a greater mechanical effect, but it requires a greater space of time; it being in the same proportion as the relative per centage between full stroke and cut-offs, or *vice versa*. During the same space of time, when cut-offs are used, and using a proportionate increase of pressure representing a greater volume of steam, the same mechanical effect will be obtained as that in following full stroke with a lesser amount of steam; or during the same space of time, and with the same amount of steam at a proportionate higher pressure, a greater mechanical effect will be obtained in using cut-offs as in following full stroke.

And now, allow me to remark, that here we have a full explanation of what has been asserted, that the mechanical effect in changing the full stroke to any part of the cut-off, during the working of the engine, was found to be greater in the latter case than in the former.

Suppose we have the same engine as that from which we drew our first deductions, *i. e.*, 200 square inches area, 6 feet stroke, and 60 lbs. pressure. Then we will have, as shown, a clear mechanical effect of 51,300 lbs., or 71¼ per cent. of the power exerted by the steam. I have further shown, that when the feeding of steam is cut-off at one-half stroke, we have a clear mechanical effect of 41,709 lbs., or 57·93 per cent., or with the same amount of steam used at full stroke, 83,418 lbs. effect, or 115·86 per cent. The fire or the production of heat not being changed in using the cut-off, it is evident that with each stroke of the engine, 4⅙ cubic feet of steam will be used less than before, the production remaining the same: and now let us take the steam space at 100 cubic feet, and the engine running only 12 revolutions per minute, and we have the startling result that, in less than one minute, the pressure in the boiler will be found to be at 100 lbs. per square inch, provided the safety valve be loaded to that amount; and its clear effect will be 83,300 lbs. lifted one foot, or 115·69 per cent., instead of 71¼ per cent. when full stroke was used. But when the safety valve remains loaded with 60 lbs. in working order, and its orifice is proportionate to the production of all the steam, then, gentlemen, there is no such thing as the engine beginning to jump, or attempting to "run away;" but, on the contrary, its speed will fall off almost immediately, until not more than 57·93 per cent. of the former 71¼ per cent. will remain.

7th. From the above deductions, drawn from calculations, we now arrive at the conclusion that a much greater mechanical effect is attained in using cut-offs instead of following full stroke, when the same volume of steam is used, or the same effect is attained with a lesser volume of steam: the consequence is, that the production of a lesser volume of steam, requiring a lesser quantity of heat, the same mechanical effect, in using cut-offs instead of following full stroke, is attained with a lesser amount of coal, all conditions being otherwise equal. Therefore, let me add, go ahead, busy inventors, and give us an improved cut-off, that will answer our purposes well, and give satisfaction to all.

MECHANICS, PHYSICS, AND CHEMISTRY.

For the Journal of the Franklin Institute.

Strength of Materials: Deduced from the latest experiments of Barlow, Buchanan, Fairbairn, Hodgkinson, Stephenson, Major Wade, U. S. Ordnance Corps, and others. By CHAS. H. HASWELL, Civil and Marine Engineer.

No. 2.

(Continued from page 343.)

TRANSVERSE STRENGTH.

The Transverse or Lateral Strength of any Beam, Rod, Bar, &c., &c., &c., is in proportion to the product of its breadth, and the square of its depth; and in like sided beams, bars, &c., it is as the cube of the side, and in cylinders as the diameter of the section.

When one end is Fixed and the other projecting, the strength is inversely as the distance of the weight from the section acted upon; and the strain upon any section is directly as the distance of the weight from that section.

When both ends are Supported, only, the strength is four times greater for an equal length, when the weight is applied in the middle between the supports, than if one end only is fixed.

When both ends are Fixed, the strength is six times greater for an equal length, when the weight is applied in the middle, than if one end only is fixed.

The strength of any rod, bar, &c., &c., to support a weight in the centre of it, *when the ends rest merely upon two supports*, compared to one *when the ends are fixed*, is as 2 to 3.

When the Weight or Strain is uniformly distributed, the weight or strain that can be supported, compared with that when the weight or strain is applied at one end or in the middle between the supports, is as 2 to 1.

In Metals, the greater the dimension of the side of a beam, &c., or the diameter of a cylinder, the less its proportionate transverse strength.

The strength of a *Cylinder*, compared to a *Square* of like diameter and sides, is as 4·71 to 8.

The strength of a *Hollow cylinder* is to that of a *Solid cylinder*, of the same length and quantity of matter, as the greater diameter of the former is to the diameter of the latter; and the strength of *hollow cylinders*, of the same length, weight, and material, is as their greatest diameters.

The strength of an *Equilateral Triangle*, having an edge up, compared to a *Square* of the same area, is as 22 to 27; and the strength of an equilateral triangle, having an *edge down*, compared to one, an *edge up*, is as 38 to 23.

NOTE.—In these comparisons the beam or bar is considered as one end being fixed, the weight suspended from the other. In Barlow, and other authors, the comparison is made when the bar or beam rested upon supports. Hence, the stress is contrariwise.

Detrusion is the resistance that the particles or fibres of materials oppose to their sliding on each other, under a detrusive strain. Punching and shearing are detrusive strains.

Deflection.—When a beam, bar, &c., &c., is deflected by a cross strain, the side of the bar, &c., which is bounded by the concave surface is *compressed* and the opposite side is *extended.*

The *Neutral Line*, or *Axis of Equilibrium*, is the line at which extension terminates and compression begins.

In Stones and Cast metals, the resistance to compression is greater than the resistance to extension.

In Woods, the resistance to extension is greater than the resistance to compression.

The general law regarding deflection is, that it increases, *cæteris paribus*, directly as the cube of the length of the rod, bar, &c., and inversely, as the breadth and cube of the depth.

The *Resilience* or toughness of a body, is a combination of flexibility and strength.

The resistance of *Flexure* of a body at its cross section is very nearly nine-tenths of its tensile resistance.

Relative Stiffness of materials to resist a transverse strain:—

Wrought Iron,	1·3	Oak,	·095
Cast Iron,	1·	Ash,	·089
White Pine,	1·	Beech,	·073
Yellow Pine,	·087	Elm,	·073

The strength of a Rectangular Beam in an *Inclined position* to resist a vertical stress, is to its strength in a horizontal position, as the square of radius, to the square of the cosine of elevation; that is:—as the square of the length of the beam, to the square of the distance between its points of support, measured upon a horizontal plane.

Beams of cast metal, having small dimensions, are stronger *pro rata* than those having larger dimensions, in consequence of their having a greater proportion of chilled surface compared to their elements of strength resulting from dimensions alone.

Experiments upon bars of cast iron, 1, 2, and 3 inches square, give a result of 447, 348, and 338 lbs., respectively; being in the ratio of 1·, ·78, and ·756.

The strongest rectangular beam that can be cut of a cylinder, is one of which the squares of the breadth and depth of it, and the diameter of the cylinder, are as 1, 2, and 3, respectively.

TABLE OF THE TRANSVERSE STRENGTH OF MATERIALS: Deduced from the experiments of U. S. Ordnance Department, Barlow, Rennie, Stephenson, Hodgkinson, Fairbairn, Pasley, Hatfield, and the Author, and reduced to a uniform measure of *One Inch Square, and One Foot in Length; Weight Suspended from one end.*

MATERIALS.	Specific gravity.	Breaking weight.	Weight borne while the elasticity was perfect.	Value of W for general use.
WOODS.				
Teak,	·745	206 lbs.	65·5 lbs.	60
Oak, English	·934	140	43·8	35
do superior	·748	188		45
Canadian	·872	146	49·5	36
American do		230		50
Dantzic	·756	122	43·8	30
African	·982	208		50
Ash,	·760	168	49 5	55
Beech,	·696	130	33·	32
Birch,	·711	160		40
Elm,	·553	82	27·5	25
		170	45·	40
Pitch Pine,	·660	136	33·	45
American	·777	160		50
White Pine,	·553	92	33·	30
American		130		45
Riga Fir,	·753	94	27·5	30
Norway Pine,	·577	123	44·	40
Locust,	·936	295		100
Deal, Christiana	·698	137		45
Larch,	·556	93	33·	25
White wood,		116		38
Maple,		202		65
Hickory		250		55
Chestnut		160		53
Riga Fir, Wet	·632	107		30
Dry	·330	96		30
METALS.				
Cast Iron, American, means of five divisions of grades.	7·087	507		125 to 160
	7·182	632		155 210
	7·246	733		180 240
	7·270	762		190 250
	7·340	772		192 250
Mean by Maj. Wade	7·225	681		170 225
West Pt. Found. extreme		980		250 325
English,—Low Moor Cold blast	7·055	472		110 140
Gartsherrie, Hot "	7·017	447		
Carron, Cold "	7·094	443		
Muirkirk, Hot "	6·953	418		
Ponkey, Cold "	7·122	581		145 190
Hot blast, mean		500		125 165
Cold " "		516		130 170
Ystalyfera, cold blast		770		195 255
Mean of 65 kinds,		500		125 165

MATERIALS.	Specific gravity.	Breaking weight.	Weight borne while the elasticity was perfect.	Value of W for general use.
METALS (Continued).				
Steel, greatest . .	7·862	1918		400 to 500
		Permanent bend.		
WROUGHT IRON				
American .	1500	700 650 600		160 210
English .	1000	400		100 130
"	1080	520		130 170
" .	1200	550		135 180
Swedish* .		665		165 220
English, the stress applied horizontally,		set. ·001 in. 190		180 240
MIXTURE OF CAST AND WROUGHT IRON, &c.				
Cast Iron, Blaenarvon .	575			145
do 10 pr. ct. of wrought	703			175
20 "	842			210
30 "	920			230
40 "	767			195
50 "	727			185
and 2½ per cent. of Nickel,	693			173
mean	750			188
Stirling, 2d quality	623			154
3d "	499			125
STONES (American).				
Flagging, Blue .	2·707	31·		
Freestone, Little Falls, N. Y.,	2·326	24·		
Belleville, N. J.,	2·300	20·1 17·8		
Connecticut .	2·462	13·		
Dorchester .	2·289	10·8		
Aubigny, .	2·472	9·3		
Caen .	2·218	6·1		
Granite, blue, coarse .	2·604	18·		
Quincy, Mass., .	2·658	26·		
STONES (English).				
Yorkshire Blue Stone, .		26·		
Paving, .		10·4		
Landing, .		22·5		
Caithness Paving, Scotland .		68·		
Valentia do., Ireland		68·5		
Welsh do., .		157·		
Arbroath, . .		17·		
Craigleith Sandstone, .	2·266	10·7		
Hailes, . .		7·4		
Felling, . .		7·5		
Kentish Rag, . .		35·8		
Cornish Granite, .		22·		
Portland Oolite, . .	2·145	21·2		
Bath, . .		5·2		
Bangor Slate, . .		90·		
Llangollen do., .		43·		

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* With 840 lbs. the deflection was 1 inch, and the elasticity of the metal destroyed.

CONCRETES (English).	Breaking weight.
Aberthaw lime 1, gravel 7,	·8
Hydraulic lime and gravel (old),	2·
Fire brick beam, Portland cement,	3·1
do, sand 3 parts, lime 1 part,	·7
CEMENTS (English).	
Portland,	37·5 30·4 10·2
do 1 part, sand 2 parts,	10·
Blue clay 5 parts, chalk 4 parts,	14·3 5·8
Blue clay and chalk,	5·4
Sheppy,	5·
BRICKS (English).	
Fire brick,	14·
Stock brick, well burned,	5·8
do inferior burned,	2·5
Old brick,	9·1
New " English,	10·7
Best stock,	11·8

COMPARATIVE TRANSVERSE STRENGTH OF A PRISM OF LIME AND CEMENT MIXED WITH VARIOUS PREPARATIONS OF GRAVEL AND SAND (Sir C. W. PASLEY).

One Inch Square, and One Foot in Length, the Weight being Suspended from one end.

MIXTURE.	Days immersed in water.	Age in days.	Breaking weight.
Chalk lime 1, Sand 3·25,	19	396	·81 lbs.
do 1, Gravel 3, Sand 4,		446	·156
do 1, Gravel 6, Sand 3,	32	446	·39
Halling lime 1, Sand 3,		342	1·40
do 1, Gravel 4, Sand 2,	18	457	1·62
do 1, Gravel 6, Sand, 3,	32	453	1·43
Blue Lias lime 1, Gravel 6, Sand 3,		345	·80
Rosehill lime 1, Sand 2,		342	1·56
Sheppy and Harwich Cements 1, and Gravel 1·5, Sand 2·0,		385	·93
Chalk 5, Blue clay 2, Gravel 1·5, Sand 2·0,		385	·156
Chalk 5, Blue clay 2, Gravel 5, Sand 2,		439	·41
Chalk 5, Blue clay 1, Gravel 3, Sand 4,	18	431	·76
Chalk 5, Blue clay 1, Gravel 6, Sand 2,	18	431	1·03
Chalk 6, Blue clay 1, Gravel 5, Sand 4,	16	429	·45
Chalk 7, Blue clay 1, Gravel 5, Sand 4,	16	429	·44
Chalk lime 1, Screened ballast 5,		270	1·12
do 1, do 10,		256	·27
Halling lime 1, do 3,		270	1·40
do 1, do 10,		270	·42
Blue Lias lime 1, Ballast, 6,		239	1·08
do 1, do 10,		268	·33
Sheppy & Harwich Cements 1, do 2,		143	1·04
do 1, do 7,		234	·12

TABLE OF THE TRANSVERSE STRENGTH OF CAST IRON BARS AND OAK BEAMS OF VARIOUS FIGURES,

Having a Uniform Sectional Area of One Square Inch, One Foot in Length, Fixed at one end, Weight Suspended from the other.

	FORM OF BAR OR BEAM.		BREAKING WEIGHT.
Cast Iron.	■	Square, . . .	673 lbs.
	◆	do, diagonal vertical, . .	568
	●	Cylinder, . . .	573
	◎	Hollow Cylinder, greater diameter twice that of less,	794
	▮	Rectangular, 2 ins deep × ½ in. thick, .	1456
		do 3 " × ⅓ " .	2392
		do 4 " × ¼ " .	2652
	▲	Equilateral triangle, an edge up, .	560
	▼	do, an edge down, .	958
	T	2 ins. deep × 2 ins. wide × ·268 ins. thick,	2068
	⊥	" " " .	555
Oak,	▲	Equilateral triangle, an edge up, .	114
	▼	do, an edge down, .	130

TABLE OF THE TRANSVERSE STRENGTH OF SOLID AND HOLLOW CYLINDERS OF VARIOUS MATERIALS,

One Foot in Length, Weight Suspended from one end.

MATERIALS.	Specific gravity.	Solid external diameter in inches.	Hollow internal diameter in inches.	Breaking weight in lbs.	Breaking weight for 1 inch external diameter, and proportionate internal diameter.
WOODS (English).					
Fir,* . .	·588	2·		772	97
Ash, .	·590	2·		685	86
" . .	·580	2·	1·	604	75
" .	·601	2·	·75	625	78
" . .	·586	2·	·50	636	79
White Pine, American		1·		75	75
"		2·		610	76
METALS.					
Cast iron, cold blast		3·		12,000	444
STONE WARE.					
Rolled pipe of fine clay.		2·87	1·928	190	8

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* An inch square batten from the same plank as this specimen, broke at 139 lbs.

RESULT OF EXPERIMENTS ON THE TRANSVERSE STRENGTH OF SCARPHED BATTENS (BARLOW.)

Battens 4 feet in length, Fixed at One end, and Loaded at the other.

[*Note.*—Dimensions of battens not given.]

Scarph, 12 inches in length, small end up, and one inch from face of fulcrum, .	Broke in the neck of the scarph, close to the fulcrum,	87 lbs.
Scarph, 12 inches in length, large end up, and one inch from face of fulcrum, .	Fastenings of small end of scarph drew out, .	101
Scarph, vertical, .	Broke in the scarph, .	211

(To be Continued.)

*The Cylindrical Spiral Boiler.** By JOHN ELDER.

The object of the construction of this boiler is to obtain a form with all the useful properties of the simple cylindrical high-pressure boiler on shore, adapted to steamships. The following advantages appear to be attained over the ordinary marine boiler, namely:

1. A form of boiler capable of carrying higher pressure and presenting more heating surface, and of a more effective description, from a given weight of material.
2. A boiler capable of being easier cleaned and repaired in both water and fire spaces.
3. A boiler capable of producing superheated steam to any practical temperature.
4. A less average specific gravity of water whilst working at sea with the usual amount of feed and blow-off, and a more perfect combustion-chamber, and better formation of flue surface.
5. The pressure being altogether internal, it is not liable to collapse, a danger lately ably demonstrated by Mr. Fairbairn; and as the diameter of the various cylinders are reduced to the minimum size for permitting the tradesmen to pass through, clean and repair them, the boiler when formed of ordinary thickness possesses enormous strength without stays.
6. The expense of the boiler per square foot of heating surface is about the same as the ordinary boiler, and is capable of carrying five times the pressure.

The general construction of this boiler is as follows:—There are twenty-four round boilers or tubes, of not less than 19 inches diameter each, twenty-two of these forming, when bound together, a cylindrical vertical shell; the twenty-third, a centre boiler concentric to that shell; and the twenty-fourth, a spiral coil-boiler winding spirally round between the centre boiler and those composing the circumference shell. These boilers contain the water, and the spaces between them the fire.

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* From the London Civ. Eng. and Arch. Jour., September, 1860.

The feed-water passes first into the spiral compartment, or No. 24, and from it into the centre compartment, or No. 23, and into each in rotation, and blows off at the last compartment, or No. 1, thus rendering the water in No. 24 nearly pure sea-water, and gradually from compartment to compartment more dense, till it blows off at No 1 at the usual density, and thus makes the average specific gravity of the water less than usual.

The twenty-two outside boilers are 24 feet long, 19 inches diameter, and $\frac{5}{16}$-inch thick; the bottom ends are conical for 3 feet, and knee'd outwardly to give a larger diameter of furnace, say 12 feet diameter. There is a furnace door for every alternate tube, or say 11 furnace doors, equally divided round the base of the boiler, giving great facility to the firemen for doing their work efficiently. In firing it is proposed to charge all the fresh coal round the circumference of the fire, in order that the hydrogen of the coal may be consumed separately from the carbon; and as the furnace has great altitude, the combustion will be completed in vertical flames from the coals, and will thus prevent the carbonic acid gas given out from the combustion of the carbon coming so much in contact with and preventing the combustion of the hydrogen, as is usual in ordinary furnaces.

The centre compartment, or No. 23, is 30 feet long, 34 inches diameter, and $\frac{3}{8}$-inch thick, with 3 feet at the bottom and top conically reduced to 18 inches diameter, forming a man-hole door; the upper end of this vertical tube forms a reservoir for the steam of the whole twenty-four compartments, and acts as a superheating apparatus, and may be carried up the funnel to the extent necessary to superheat the steam to 400°. The steam-pipe is taken from the top of this boiler to the safety-valve chest, fastened on the front of the boiler low down, which serves as a water-trap during the discharge from the safety-valve chest, the steam-pipe to the engines being taken off the same pipe at a higher level than the escape steam. The spiral compartment, or No. 24, is about 100 feet long, 34 inches diameter, and $\frac{3}{8}$-inch thick, made of the best iron boiler-plate; the ends are conical for 3 feet formed into man-hole doors; this spiral boiler makes four or five convolutions close round the centre one, and is bound close to the circumferential boilers by hollow stay-bolts, and fastened to the centre one at each end only; in the same manner the steam and water flows through the whole boiler by these hollow bolts or rivets, and completes the entire circulation of water and steam. The whole of these 24 compartments or boilers terminate at the bottom about 1 foot below the fire-grate, and are supported on six stanchions from the ash-pit beneath, making a free passage for the air under the grate bar; the circumferential compartments or boilers terminate at the top 6 feet above the ship's deck, and have each a man-hole door forming the cover; the funnel is made conical at the bottom to embrace the internal diameter of the boiler shell and draw off the smoke in the usual manner. This completes the whole boiler proper, but in order to prevent radiation of heat, a thin outer casing of iron is made (9 inches) clear of the boiler all round, terminating about 7 feet from the stoke-hole floor; and above, at the level of the galley or funnel-house, this casing is lined with felt and thin wood, to keep the deck and the adjacent parts cool and retain the heat. The twenty-two straight cylindrical boilers or compartments are constructed in the sides by four plates 24 feet long and 16 inches broad, rolled to a 9½-inch radius curve at the iron works, leaving no plate-setting for the boiler-maker of this description.

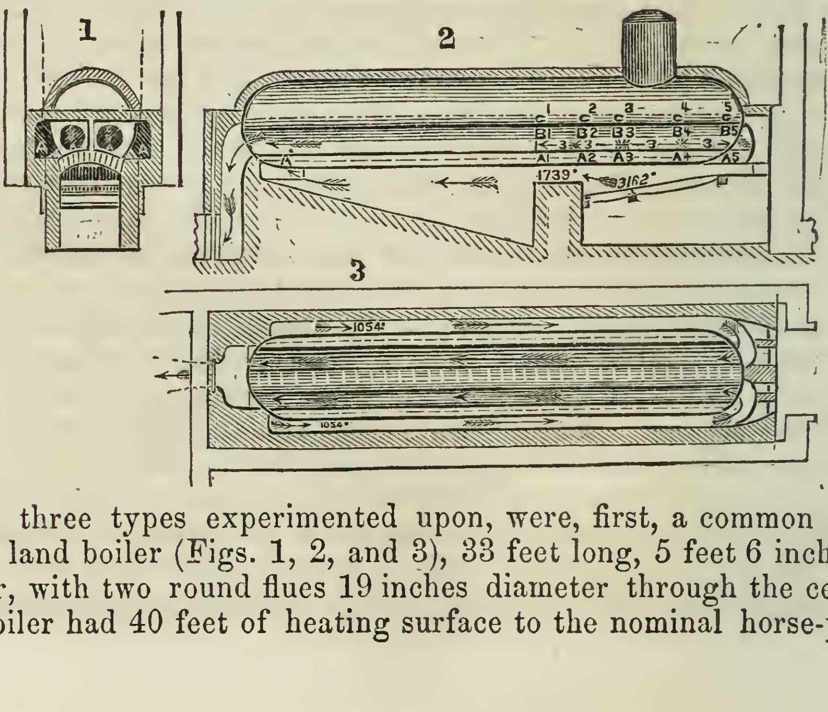
The plates of boiler No. 24, or the spiral compartment, are delivered flat by the iron-maker, and are bent to the spiral curve by one blow of a large spiral concave block falling upon a counterpart convex one, prepared by the constructors of the boiler. This operation has been found to simplify the making of this spiral cylindrical boiler to about the same amount as the straight cylindrical boilers. The conical ends are bent in the same manner as the spiral plates, and the whole work of plate-bending reduced as far as possible to machine work. The products of combustion, after leaving the furnace, have to travel spirally upwards a distance of 100 feet, and must of necessity be continually rotating during that time, and prevent the possibility of any portion passing off without being brought frequently in contact with the heating surface of the boiler, and will therefore be cooled down to the minimum temperature compatible with a given amount of cooling surface, or the greatest quantity of heat extracted from the products of combustion before their escape to the atmosphere.

This spiral coil and all the heating surfaces will keep more clear of flue-dust than usual, and will consequently be more efficient in that respect, as well as save the usual trouble and loss by spunging experienced in the ordinary tubular boilers at sea. Also, as the products of combustion must pass off at the rate of at least 7 feet per second, in this as in ordinary boilers, it will take upwards of 14 seconds from the time it leaves the furnace till it arrives at the top of the boiler; whilst if the boiler were of the ordinary tubular type it would pass in about two seconds along the whole heating surface of the boiler; the gas has, therefore, seven times more time to give out its heat, and its revolving tendency will not admit of the same stratum of gas passing along the passages after it is cooled down, as is the case with the ordinary boiler, but will bring the hot products of combustion usually occupying the centre of the tubes of a tubular boiler into contact with the cooling surfaces, and reduce the whole products of combustion to one temperature before entering the chimney.

In cleaning the salt or sludge out of these boilers the man and sludge hole doors are taken off the top and bottom (and the hose of fresh water may be played down through from the top, and the refuse run out at the bottom). The man in charge can also pass down through the whole boiler; the dimensions necessary for this purpose being made the minimum and maximum of the various compartments of the boiler; and are specially constructed to maintain to the engines steam at a much higher pressure than usual, in order to admit of a much larger amount of expansion to be developed by the engines, which are all on the double cylinder expansive principle. The constructors are now making the boilers for three steamships on this principle, two of which are for carrying Her Majesty's mails on the Pacific between Valparaiso and Panama (as described by the writer at the meeting of the British Association at Leeds); and it has long been his desire to be able to construct boilers for marine purposes without stays, and with no surface exposed to the collapsing tendency, which in so many cases has been the cause of loss of life aboard of steam-ships. The boilers now described have no large flat surfaces and no stays, the whole tendency of the pressures being to inflate the boiler plates, and, if possible, to give them a stronger form; the smallest diameter is large enough to give access to the men in charge, and the largest diameter is 34 inches, and $\frac{3}{8}$-inch thick,—dimensions that can carry several hundred pounds pressure on the square inch before rupture could take place. Such a form the writer adopts with great satisfaction to himself as a constructor sending machinery abroad, where the usual form of boiler gives him considerable anxiety. In comparing the construction of this boiler with that of the ordinary tubular one, in the latter angle-iron ribs and stays now compose a large portion of the weight and expense; contribute no heating surfaces; and if one stay breaks, which is no uncommon occurrence, the next is placed in great danger, and if it gives way the whole may follow in rotation and a serious accident be the result. In the former boiler, however, the plates may be reduced to a very small amount of thickness by tear and wear before explosion could be expected.

Having thus described the objects of the spiral boiler, it might not be out of place to give the following statement of the comparative evaporative power and temperature of the gases in the furnace and chimney of the spiral boiler, with three of the ordinary types of boiler now in general use.

Figs. 1, 2, and 3.



The three types experimented upon, were, first, a common cylindrical land boiler (Figs. 1, 2, and 3), 33 feet long, 5 feet 6 inches diameter, with two round flues 19 inches diameter through the centre; this boiler had 40 feet of heating surface to the nominal horse-power of the engine; the two flues contained 20 feet, and the shell 20 feet per nominal horse-power; the furnace was below the boiler at the fore end, had a fire-grate of 26 square feet, the fire passed underneath the boiler to the opposite end from the furnace, and returned along the sides, and then passed back again through the flues to the chimney. The temperature above the centre of the fire was found to be, on one occasion, 3200°; at the top of the bridge 1730°; the temperature of the gases gradually reduced as they passed back the remaining length of 26 feet under the boiler and along the side flues, till they entered the flues at 1163°, and left them at 800°. Thus the furnace containing a surface of 2 feet per nominal horse-power reduced the heat about 1500°, the shell of the boiler behind the furnace of about 18 feet per nominal horse-power reduced the temperature about 600°, and the flues containing a surface of 20 feet per nominal horse-power reduced the temperature about 350°. The temperatures of the gases in the flues were found to be about the same in the centre as at the top; but at the bottom of the flues, the temperatures of the gases were at the fore-end rather less than at the top, but towards the back-end the temperature of the bottom of the flues reduced gradually below the temperature at the top to the extent of 300°. Upon another occasion the temperature over the centre of the fire was found to be 3610°; at the top of the bridge 1739°; and the different temperatures of the flues were as indicated in Fig. 2, where the average temperatures of the flues at B^1=826°, B^2=879°, B^3=937°, B^4=959°, and at B^5=981. The temperatures at the top of the flues at C^3=982°, C^4=1034°, C^5=1087°. The temperatures at the bottom of the flues at A^1=571°, A^2=603°, A^3=678°, A^4=764°, A^5=822°. It would therefore appear that, notwithstanding the large amount of surface in this boiler, the evaporative power is very inferior, as the amount of heat taken out of the gases per square foot of heating surface is very small; and the natural conclusion is that the gases pass along in straight lines, and only the thin strata in contact with the surface is cooled down. In the results of the spiral boiler (Fig. 6) three times the quantity of heating surface was found to reduce six times the quantity of gas from the same temperature of 3200° to a temperature of 480° instead of 800°, showing that a more complete turning over of the gases is much wanted in our land boilers. The water evaporated per hour in the land boiler referred to was found by meter to be 2000 lbs., and the coal, best Glasgow quality, found to be 300 lbs. per hour; making about 6½ lbs. of water per pound of coal. During the measurement of the water evaporated by the meter, indicator diagrams of the engine were taken with a view to calculate the weights of steam by the ordinary method, and the calculations were found to agree with the meter; these calculations can be repeated and substantiated at any time.

The second type of boiler tested was that of the ordinary steamboat horizontal tubular boiler (Fig. 4); the example chosen was one in a first-class ocean steamer. The temperature of the furnace was found to be 3200°, and the inside of the funnel about 1100°. The heating surface of this boiler was 22 feet per nominal horse-power, and the water evaporated about 8½ lbs. per pound of coal according to the calculations from the diagrams. The coal consumed was about 20 lbs. per square foot of fire-grate, of the best Glasgow coal.

The next example taken was that of a first-class vertical tubular boiler (Fig. 5), on Mr. David Napier's principle, now universally liked on the Clyde for river steamers. This boiler had a surface of about 22 feet per nominal horse-power; the temperature of the fire was found to be about 3300°, and in the funnel 1160°; the weight of water evaporated was found by calculation to be 8¾ lbs. per pound of coal consumed, and the rate of combustion about 20 lbs. per square foot of fire-grate.

Fig 4.

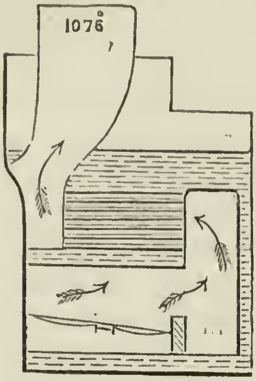


Fig. 5.

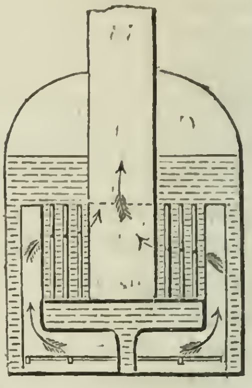
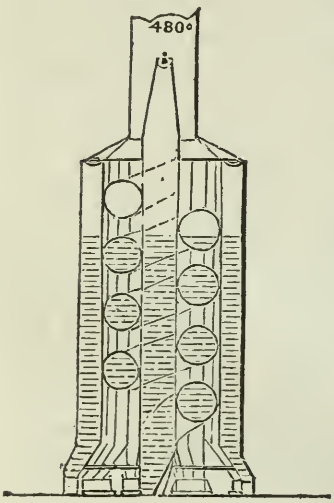


Fig. 6.



In the spiral boiler (Fig. 6) of the *San Carlos*, *Guayaquil*, and *Prinz van Orange*, the boilers were found to give the following peculiar results:—1st, that even with Scotch coal there was no smoke emitted from the chimney, and no carelessness on the part of the fireman seemed to effect the formation of smoke; 2d, that the boilers showed a bright furnace, indicating first-class draft; the temperature of the funnel was found to be 480° while the fire was at its greatest energy. The heating surface was, in the case of the *San Carlos* and *Guayaquil*, 2200 square feet, the coal consumed 1400 lbs. per hour, and the water evaporated 11 lbs. per pound of coal consumed; the fire-grate contained about 76 square feet, and the rate of combustion about 20 lbs. per square foot of fire-grate. The heating surface of the boiler was 18 feet per nominal horse-power; the coal consumed was Glasgow best steam coal. The stoke-hole was found to be remarkably cool, and the boiler, which was loaded to 52 lbs. on the square inch steam pressure, and tested to 150 lbs. on the square inch water pressure, was found to be perfectly tight. In the case of the *San Carlos*, I may mention that the ship has now steamed about 20,000 miles, and has not been in any port more than three days; during that time she has been consuming soft Chili coal for a considerable part of her voyage, and the merits of the long flue show a decided advantage in this boiler over the ordinary tubular boiler for the native bituminous coal of South America.

In order to give in a more extended form the comparative evaporative power of various flue and tubular boilers, the writer begs to lay before the Association the accompanying table. It shows several proportions of heating surface and evaporative power of several ships that have come under his notice. He can certify the accuracy of most of these particulars, except that shown in the last column, which is taken from Professor Rankine's report on the performance of the *Thetis*. This vessel has about six times more heating surface in her boilers in proportion to the coal consumed than any example the writer is aware of. The boiler is Craddock's patent boiler, though that inventor's name appears rarely to be mentioned in connexion with the said vessel. Efficient, however, as this boiler must be as an evaporator, it cannot possibly accomplish the quantity shown in the table.

Comparisons of certain Results obtained from Certified Diagrams of Steamers.

	Elk.	Earl of Ab'rd'n.	Valparaiso.	Pride of Erin.	Inka.	Europa.	Camb'n.	Thetis.
Nominal horse-power,	250	380	320	400	80	648	472	80
Indicated "	780	780	826	960	272	1207	1072	226
Propor'n of indicated H.P. to nominal ditto,	3·28	2·05	2·581	2.4	3·8	1·863	2·272	2·82
Diameter of cylinder,	57 in.	70 in.	Two 52 Two 90	72	Two 28 Two 48	90	77·5	One 21 One 42
Length of stroke.	5 ft. 6 in.	6 ft.	5 ft.	5 ft. 6 in.	3 ft.	8 ft.	7 ft. 6 in.	2 ft. 6 in.
No. strokes per minute.	25	17·5	24	22	32	15½	16	52
Boilers—flue or tubular,	Tubular.	Flue.	Flue.	Flue.	Flue.	Flue.	Flue.	Craddock's Patent.
Area of fire-grate.	144 ft.	190	130	252	50	314	247	
Area of heating surface,	4000	4300	2400	4400	480	7000	5400	Ab't 4000
Coals consumed per h.,	3360 lb.	3584	2520	4928	672	5100	4480	226
Quality of coal.	Glasgow best.	Newcastle.	Welsh.	Welsh.	Welsh.	Welsh.	Welsh.	Good.
St. ev't'd per lb. of coal,	7·354	6·87	7·74	7·159	8·1	7·7	7·509	Ab't 15 lb.
Estimate. water ev'ted,	8·1	7·4	8·6	7·9	9·0	8·5	8·3	18 lb.
Coal consumed per I.H.P.,	4·071	4·385	3·05	5·126	2·47	4·2	4·17	1·018
Fire-grate per nom. H.P.,	·576	·5	·406	·63	·625	·484	·536	

The theoretical quantity of water capable of being heated from 90°, and evaporated at, say 212°, with an infinite quantity of heating surface and a perfect fire, is somewhere about 13½ lbs. per pound of coal; whilst from the diagrams represented in Prof. Rankine's report of the *Thetis*' performance, 18 lbs. weight appears to be about the quantity of water per pound of coal. This calculation I have made from the diagrams published, and any party interested may repeat the calculations.

The calculation is made as follows:—The area of the large cylinder as shown in the diagram is 1380 square inches, or 9·583 square feet. The four revolutions of piston marked on the diagram, 49½, 52, 53, and 52 revolutions per minute, with a stroke of 2½ feet, or say 258·12 feet per minute, gives 258·12 × 9·583 × 60 = 146433 cubic feet per hour. And if we take the average pressure shown in the four diagrams at the end of the piston stroke, supposing the barometer to be 14·5 lbs., we find the weight of that steam to be about 44 cubic feet per lb.; this number, therefore, divided by 44, gives the quantity of steam as 3300 lbs.

per hour; to this must be added one-twentieth for contents of ports and clearance, which makes 3465 lbs. of steam.

This clearly gives the weight of the steam per hour given out of the cylinders after the work is performed; to this, therefore, must be added the quantity of heat that must have disappeared during the performance of the work; this in the case of the *Thetis* is about $\frac{1}{5}$ of the entire heat; we must, therefore, add $\frac{1}{5}$, or, say, $3465 + 693 = 4158$ lbs. of water must have been raised from a temperature of about 100° and evaporated, or say 18 lbs. of water to the pound of coal said to be consumed. This result is about equal to 20 lbs. of water evaporated at 212° to the pound of coal consumed; a quantity quite absurd.

It would therefore appear, before a proper comparison could be established between the merits of the *Thetis*' boiler and that of any other boiler, a correct trial of the former would be necessary. In the meantime we have but to consider that the report of Prof. Rankine was based on one hour's consumption of, say 230 lbs. of coal, and compare that with a mass of boiler, water, and fire-brick weighing 20 tons, at a temperature of, say 300°, it is evident that the mass of heat in proportion to the coal consumed is so great that no conclusion should be made from such an experiment; also, that when the quantity of coal said to be consumed, viz., 230 lbs., is compared with area of fire-grate, say 40 square feet, it is evident that the result should not be depended upon, as no ordinary comparisons could be made of the condition of the fires before and after the experiment. In conclusion, let me ask of every one present to consider the trial trips of steamships and boilers in their true light, and before drawing any inference from such trials, make a perusal of results obtained from sea voyages. The evaporative power and economy of boilers is one of the most important subjects for this Society to consider. We need only to refer to the report drawn up by the Steam Shipping Committee of the British Association to show how mixed up the question of the relative efficiency of the boilers and engines is generally considered. Indeed, the American navy returns form the only reports showing the evaporative power of the boilers in this list, and the whole merit of a good evaporating boiler is often sacrificed to the character of the engines. With regard to the *Thetis*, I would recommend any mistake to be remedied as soon as possible, as there are many contracts of a most responsible nature formed in consequence of this report, that will lead to serious loss and disappointment to the steam shipping interest and to the engineering profession of this country.

A Sheet of Paper Four Miles Long.[*]

A sheet of tissue paper has been exhibiting at Colyton, Devonshire. It measures in length four miles, being 21,000 feet long, and is in breadth 6 feet 3 inches. The weight of it is but 196 pounds. It was manufactured in twelve hours.

[*] From the London Builder, No. 906.

A Course of Lectures, consisting of Illustrations of the Various Forces of Matter, i.e. *of such as are called the Physical or Inorganic Forces.*[*]

By M. FARADAY, D. C. L., F. R. S.

LECTURE VI. (Jan. 7, 1860.)—*The Correlation of the Physical Forces.*

We have frequently seen during the course of these lectures, that one of those powers or forces of matter of which I have written the names on that board, has produced results which are due to the action of some other force. Thus, you have seen the force of electricity acting in other ways than in attracting; you have also seen it combine matters together or disunite them by means of its action on the chemical force; and in this case, therefore, you have an instance in which these two powers are related. But we have other and deeper relations than these; we have not merely to see how it is that one power affects another—how the force of heat affects chemical affinity, and so forth, but we must try and comprehend what relation they bear to each other, and how these powers may be changed one into the other; and it will to-day require all my care, and your care too, to make this clear to your minds. I shall be obliged to confine myself to one or two instances, because to take in the whole extent of this mutual relation and conversion of forces would surpass the human intellect.

In the first place, then, here is a piece of fine zinc-foil, and if I cut it into narrow strips and apply the power of heat to it, admitting the contact of air at the same time, you will find that it burns; and then, seeing that it burns, you will be prepared to say that there is chemical action taking place. You see all that I have to do is to hold the piece of zinc at the side of the flame so as to let it get heated, and yet to allow the air which is flowing in to the flame from all sides to have access to it;—there is the piece of zinc burning just like a piece of wood, only brighter. A part of the zinc is going up into the air in the form of that white smoke, and part is falling down on to the table. This, then, is the action of chemical affinity exerted between the zinc and the oxygen of the air. I will show you what a curious kind of affinity this is by an experiment which is rather striking when seen for the first time. I have here some iron filings and gunpowder, and will mix them carefully together with as little rough handling as possible; now we will compare the combustibility, so to speak, of the two. I will pour some spirit of wine into a basin and set it on fire; and having our flame, I will drop this mixture of iron filings and gunpowder through it, so that both sets of particles will have an equal chance of burning. And now tell me which of them it is that burns. You see a plentiful combustion of the iron filings; but I want you to observe that though they have equal chances of burning, we shall find that by far the greater part of the gunpowder remains untouched; I have only to drain off this spirit of wine and let the powder which has gone through the flame dry, which it will do in a few minutes, and I will then test it with a lighted match. So ready is the iron to burn, that it takes, under certain circumstances, even less time to catch fire than gunpowder. [As soon as the gunpowder was dry Mr. Anderson handed it to the Lecturer, who applied a lighted match to it, when the sudden flash showed how large a proportion of gunpowder had escaped combustion when falling through the flame of alcohol.]

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[*] From the Lond. Chemical News, No. 10.

These are all cases of chemical affinity, and I show them to make you understand that we are about to enter upon the consideration of a strange kind of chemical affinity, and then to see how far we are enabled to convert this force of affinity into electricity or magnetism, or any other of the forces which we have discussed. Here is some zinc (I keep to the metal zinc as it is very useful for our purpose), and I can produce hydrogen gas by putting the zinc and sulphuric acid together as they are in that retort; there you see the mixture which gives us hydrogen—the zinc is pulling the water to pieces and setting free hydrogen gas. Now we have learned by experience that if a little mercury is spread over that zinc, it does not *take away* its power of decomposing the water, but *modifies* it most curiously. See how that mixture is now boiling, but when I add a little mercury to it the gas ceases to come off. We have now scarcely a bubble of hydrogen set free, so that the action is suspended for the time. We have not *destroyed* the power of chemical affinity, but modified it in a wonderful and beautiful manner. Here are some pieces of zinc covered with mercury exactly in the same way as the zinc in that retort is covered, and if I put this plate into sulphuric acid I get no gas, but this most extraordinary thing occurs, that if I introduce along with the zinc another metal which is *not* so combustible, then I reproduce all the action. I am now going to put to the amalgamated zinc in this retort some portions of copper wire (copper not being so combustible a metal as the zinc), and observe how I get hydrogen again, as in the first instance—there, the bubbles are coming over through the pneumatic trough, and ascending faster and faster in the jar; the zinc, so to speak, is acting by reason of its contact with the copper.

Every step we now take brings us to a knowledge of new phenomena. That hydrogen which you now see coming off so abundantly does not come from the zinc as it did before, *but from the copper.* Here is a jar containing a solution of copper. If I put a piece of this amalgamated zinc in it, and leave it there, it has hardly any action, and here is a plate of platinum which I will immerse in the same solution, and might leave it there for hours, days, months, or even years, and no action would take place. But now I put them both in together, and let them touch each other (Fig. 1). See what a coating of copper there is immediately thrown down on the platinum. Why is this? The platinum has no power of itself to reduce the metal from that fluid, but it has in some mysterious way received this power by its contact with the metal zinc. Here, then, you see a strange transfer of chemical force from one metal to another—the chemical force from the zinc is transferred, and made over to the platinum by the mere association of the two metals. I might take instead of the platinum, a piece of copper or silver, and it would have no action of its own on this solution, but the moment the zinc was introduced and touched to the other metal, then the action would take place, and it would become covered with copper. Now, is not this most wonderful and beautiful to see? we still have the identical chemical force of the particles of zinc acting, and yet in some strange manner we have power to make that chemical force, or something it produces, travel from one place to another—for we do make the chemical force travel from the zinc to the platinum by this very curious experiment of using the two metals in the same fluid in contact with each other.

Fig. 1.

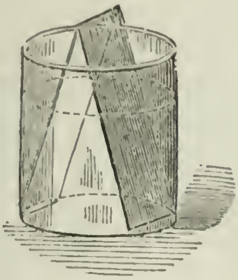
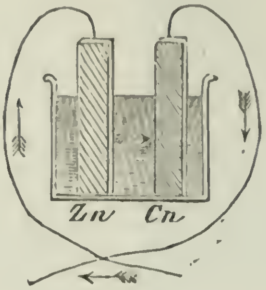
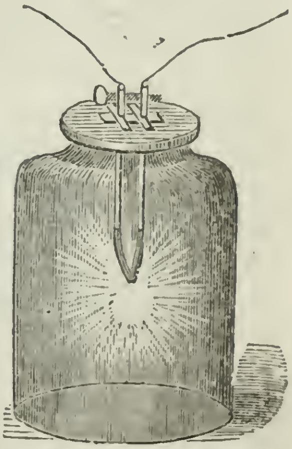


Fig. 2.



Let us now examine these phenomena a little more closely. Here is a drawing (Fig. 2) in which I have represented a vessel containing the acid liquid and the slips of zinc and platinum or copper, and I have shown them touching each other *outside* by means of a wire coming from each of them (for it matters not whether they touch in the fluid or outside—by pieces of metal attached they still by that communication between them, have this power transferred from one to the other). Now, if instead of using only one vessel, as I have shown there, I take another, and another, and put in zinc and platinum, zinc and platinum, zinc and platinum, and connect the platinum of one vessel with the zinc of another, the platinum of this vessel with the zinc of that, and so on, we should only be using a series of these vessels instead of one. This we have done in that arrangement which you see behind me. I am using what we call a Grove's voltaic battery, in which one metal is zinc and the other platinum, and I have as many as forty pairs of these plates all exercising their force at once in sending the whole amount of chemical power there evolved through these wires under the floor and up to these two rods coming through the table. We need do no more than just bring these two ends in contact, when the spark shows us what power is present; and what a strange thing it is to see that this force is brought away from the battery behind me, and carried along through these wires. I have here an apparatus (Fig. 3) which Sir Humphry Davy constructed many years ago, in order to see whether this power from the voltaic battery caused bodies to attract each other in the same manner as the ordinary electricity did. He made it in order to ex-

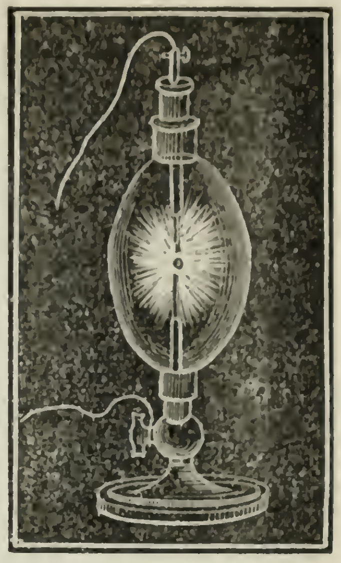
Fig. 3.



periment with his large voltaic battery, which was the most powerful then in existence. You see there are in this glass jar two leaves of gold, which I can cause to move to and fro by this rack work. I will connect each of these gold leaves with separate ends of this battery, and if I have a sufficient number of plates in the battery I shall be able to show you that there will be some attraction between those leaves even before they come in contact; if I bring them sufficiently near when they are in communication with the ends of the battery, they will be drawn gently together, and you will know when this takes place, because the power will cause the gold leaves to burn away, which they could only do when they touched each other. Now I am going to cause these two leaves of gold to approach gradually, and I have no doubt that some of you will see that they approach before they burn, and those who are too far off to see them approach will see by their burning that they have come together. Now they are attracting each other, long before the connexion is complete, and there they go! burnt up in that brilliant flash, so strong is the force. You thus see, from the attractive force at the two ends of this battery, that these are really and truly electrical phenomena.

Now let us consider what is this spark. I take these two ends and bring them together, and there I get this glorious spark like the sunlight in the heavens above us. What is this? It is the same thing which you saw when I discharged the large electrical machine, when you saw one single bright flash; it is the same thing, only *continued*, because here we have a more effective arrangement. Instead of having a machine which we are obliged to turn for a long time together, we have here a *chemical* power which sends forth the spark—and it is wonderful and beautiful to see how this spark is carried about through these wires. I want you to perceive, if possible, that this very spark and the heat it produces (for there is heat), is neither more nor less than the chemical force of the zinc—its *very* force carried along wires and conveyed to this place. I am about to take a portion of the zinc and burn it in oxygen gas for the sake of showing you the kind of light produced by the actual combustion in oxygen gas of some of this metal. [A tassel of zinc-foil was ignited at a spirit lamp and introduced into a jar of oxygen, when it burnt with a brilliant light.] That shows you what the affinity is when we come to consider it in its energy and power. And the zinc is being burned in the battery behind me at a much more rapid rate than you see in that jar, because the zinc is there dissolving and *burning*, and produces here this great electric light. That very same power which in that jar you saw evolved from the actual combustion of the zinc in oxygen is carried along these wires and made evident here, and you may if you please consider that the zinc is burning in those cells, and that *this* is the light of that burning [bringing the two poles in contact and showing the electric light]; and we might so arrange our apparatus as to show that the amounts of power evolved in either case are identical. Having thus obtained power over the chemical force, how wonderfully we are able to convey it from place to place; when we use gunpowder for explosive purposes, we can send into the mine chemical affinity by means of this electricity; not having provided fire beforehand, we can send it in at the moment we require it. Now here (Fig. 4) is a vessel containing two charcoal points, and I bring it forward as an illustration of the wonderful power of conveying this force from place to place. I have merely to connect these by means of wires to the opposite ends of the battery, and bring the points in contact. See! what an exhibition of force we have. We have exhausted the air so that the charcoal cannot burn, and therefore the light you see is really the burning of the zinc in the cells behind me —there is no disappearance of the carbon, although we have that glorious electric light; and the moment I cut off the connexion it stops. Here is a better instance to enable some of you to see the certainty with which we can convey this force where, under ordinary circumstances, chemical affinity would not act. We may absolutely take these two charcoal poles down under water, and get our electric light there;—there they are in the water, and you observe when I bring them into connexion we have the same light as we had in that glass vessel.

Fig. 4.



Now, besides this production of light we have all the other effects and powers of burning zinc. I have a few wires here which are not combustible, and I am going to take one of them, a small platinum wire, and suspend it between these two rods which are connected with the battery, and when contact is made at the battery see what heat we get (Fig. 5). Is not that beautiful?—it is a complete bridge of power. There is metallic connexion all the way round in this arrangement, and where I have inserted the platinum, which offers some resistance to the passage of the force, you see what an amount of heat is evolved,—this is the heat which the zinc would give if burnt in oxygen, but as it is being burnt in the voltaic battery it is giving it out at this spot. I will now shorten this wire for the sake of showing you that the shorter the obstructing wire is, the more and more intense is the heat, until at last our platinum is fused and falls down, breaking off the circuit.

Fig. 5.

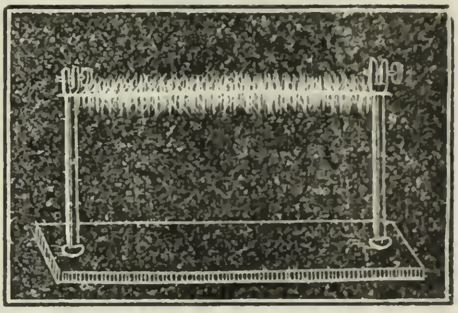
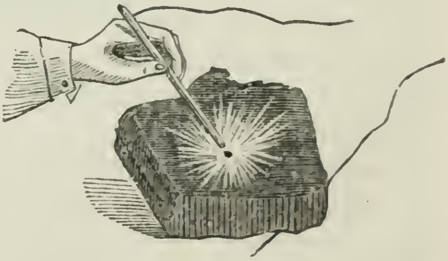


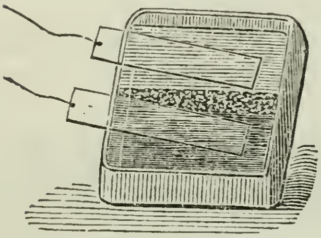
Fig. 6.



Here is another instance. I will take a piece of the metal silver and place it on charcoal connected with one end of the battery, and lower the other charcoal pole on to it—

see how brilliantly it burns (Fig. 6). Here is a piece of iron on the charcoal, see what a combustion is going on; and we might go on in this way burning almost every thing we placed between the poles. Now, I want to show you that this power is still chemical affinity—that if we call the power which is evolved at this point *heat* or *electricity*, or any other name referring to its source, or the way in which it travels, we still shall find it to be chemical action. Here is a colored liquid which can show by its change of color the effects of chemical action; I will pour part of it into this glass, and you will find that these wires have a very strong action. I am not going to show you any effects of combustion or heat, but I will take these two platinum plates, and fasten one to the one pole and the other to the other end, and place them in this solution, and in a very short time you will see the blue color will be entirely destroyed. See, it is colorless now—I have merely brought the end of these wires into the solution of indigo, and the power of electricity has come through these wires and made itself evident by its chemical action. There is also another curious thing to be noticed now we are dealing with the chemistry of electricity, which is that the chemical power which destroys the color is only due to the action on one side. I will pour some more of this sulphindigotic acid into a flat dish, and will then make a porous dyke of sand separating the two portions of fluid into two parts (Fig. 7), and now we shall be able to see whether there is any difference in the two ends of the battery, and which it is that possesses this peculiar action. You see it is the one on my right hand which has the power of destroying the blue, for the portion on that side is thoroughly bleached, while nothing has apparently occurred on the other side. I say *apparently*, for you must not imagine, that because you cannot perceive any action none has taken place.

Fig. 7.

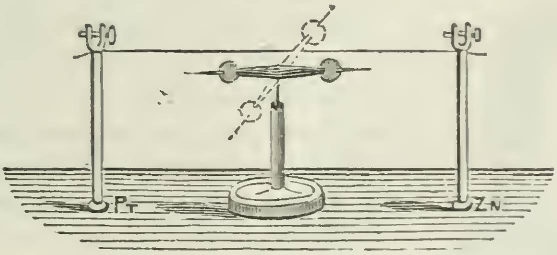


Here we have another instance of chemical action. I take these platinum plates again and immerse them in this solution of copper from which we formerly precipitated some of the metal, when the platinum and zinc were both put in it together. You see that these two platinum plates have no chemical action of any kind, they might remain in the solution as long as I liked, without having any power of themselves to reduce the copper; but the moment I bring the two poles of the battery in contact with them, the chemical action which is there transformed into electricity and carried along the wires, again becomes chemical action at the two platinum poles, and now we shall have the power appearing on the left hand side, and throwing down the copper in the metallic state on the platinum plate; and in this way I might give you many instances of the extraordinary way in which this chemical action or electricity may be carried about. That strange nugget of gold, of which there is a model in the other room, and which has an interest of its own in the natural history of gold, and which came from Ballarat, and was worth £8000 or £9000 when it was melted down last November, was brought together in the bowels of the earth, perhaps ages and ages ago, by some such power as this. And there is also another beautiful result dependent upon chemical affinity in that fine lead-tree, the lead growing and growing by virtue of this power. The lead and the zinc are combined together in a little voltaic arrangement, in a manner far more important than the powerful one you see here, because in nature these minute actions are going on for ever, and are of great and wonderful importance in the precipitation of metals and formation of mineral veins, and so forth. These actions are not for a limited time, like my battery here, but they act for ever in small degrees, accumulating more and more of the results.

I have here given you all the illustrations that time will permit me to show you of chemical affinity producing electricity, and electricity again becoming chemical affinity. Let that suffice for the present; and let us now go a little deeper into the subject of this chemical force, or this electricity—which shall I name first?—the one producing the other in a variety of ways. These forces are also wonderful in their power of producing another of the forces we have been considering, namely, that of magnetism, and you know that it is only of late years, and long since I was born, that the discovery of the relations of these two forces of electricity and chemical affinity to produce magnetism have become known. Philosophers had been suspecting this affinity for a long time, and had long had great hopes of success—for in the pursuit of science we first start with hopes and expectations; these we realize and establish never again to be lost, and upon them we found new expectations of further discoveries, and so go on pursuing, realizing, establishing, and founding new hopes again and again.

Now observe this: here is a piece of wire which I am about to make into a bridge of force, that is to say, a communicator between the two ends of the battery. It is copper wire only, and is therefore not magnetic of itself. We will examine this wire with our magnetic needle (Fig. 8), and though connected with one extreme end of the battery, you see that before the circuit is completed it has no power over the magnet. But observe it when I make contact; watch the needle, see how it is swung round, and notice how indifferent it becomes if I break contact again; so you see we have this wire evidently affecting the magnetic needle under these circumstances. Let me show you that a little more strongly. I have here a quantity of wire which has been wound into a spiral, and this will affect the magnetic needle in a very curious manner, because, owing to its shape, it will act very like a real

Fig. 8.



magnet. The copper spiral has no power over that magnetic needle at present, but if I cause the electric current to circulate through it, by bringing the two ends of the battery in contact with the ends of the wire which forms the spiral, what will happen? Why one end of the needle is most powerfully drawn to it; and if I take the other end of the needle it is repelled; so you see I have produced exactly the same phenomena as I had with the bar magnet,—one end attracting and the other repelling. Is not this then curious to see that we can construct a magnet of copper? Furthermore, if I take an iron bar, and put it inside the coil, so long as there is no electric current circulating round, it has no attraction,—as you will observe if I bring a little iron filings or nails near the iron. But now if I make contact with the battery they are attracted at once. It becomes at once a powerful magnet, so much so that I should not wonder if these magnetic needles on different parts of the table pointed to it. And I will show you by another experiment what an attraction it has. This piece and that piece of iron, and, many other pieces are now strongly attracted (Fig. 9), but as soon as I break contact the power is all gone and they fall. What then can be a better or a stronger proof than this of the relation of the powers of magnetism and electricity? Again, here is a little piece of iron which is not yet magnetized. It will not at present take up any one of these nails; but I will take a piece of wire and coil it round the iron (the wire being covered with cotton in every part so that it does not touch the iron), so that the current must go round in this spiral coil; I am, in fact, preparing an *electro-magnet* (we are obliged to use such terms to express our meaning, because it is a magnet made by electricity,—because we produce by the force of electricity a magnet of far greater power than a permanent steel one). It is now completed, and I will repeat the experiment which you saw the other day, of building up a bridge of iron nails; the contact is now made and the current is going through; it is now a powerful mag-

Fig. 9.

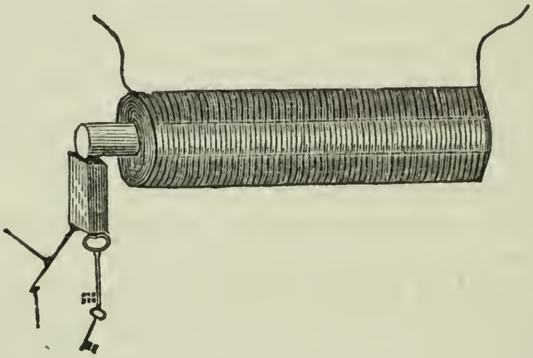
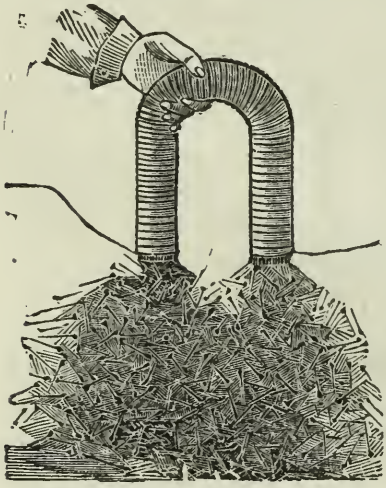
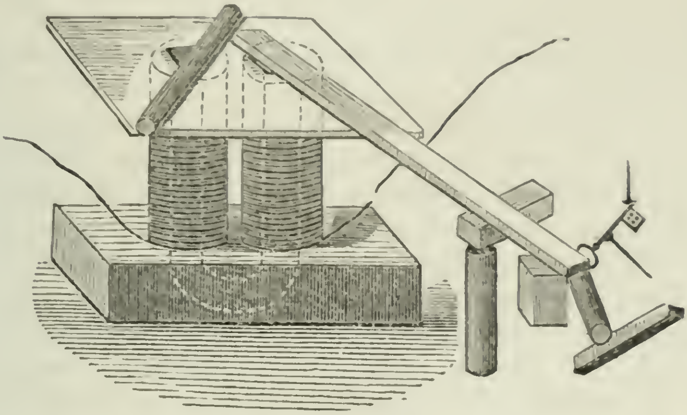


Fig. 10.



net; here are the iron nails which we had the other day, and now I have brought this magnet near them they are clinging so hard that I can scarcely move them with my hand (Fig. 10). But when the contact is broken, see how they fall. What can show you better than such an experiment as this, the magnetic attraction with which we have endowed these portions of iron? Here again is a fine illustration of this strong power of magnetism. It is a magnet of the same sort as the one you have just seen. I am about to make a current of electricity pass through the wires which are round this iron for the purpose of showing you what powerful effects we get. Here are the poles of the magnet; and let us place on one of them this long bar of iron. You see as soon as contact is made how it rises in position (Fig. 11); and if I take such a piece as this cylinder, and place it on, wo be to me if I get my finger between; I can roll it over, but if I try to pull it off, I might lift up the whole magnet, but I have no power to overcome the magnetic power which is here evident. I might give you an infinity of illustrations of this high magnetic power. There is that long bar of iron held out, and I have no doubt if I were to examine the other end I should find that it was a magnet. See what power it must have to support not only these nails but all these lumps of iron hanging on to the end. What then can surpass these evidences of the change of chemical force into electricity, and electricity into magnetism? I might show you many other experiments whereby I could obtain electricity and chemical action, heat and light from a magnet, but what more need I show you to prove the universal correlation of the physical forces of matter, and their mutual conversion one into another?

Fig. 11.



And now let us give place as juveniles to the respect we owe to our elders; and for a time let me address myself to those of our seniors who have honored me with their presence during these lectures. I wish to claim this moment for the purpose of tendering our thanks to them, and my thanks to you all for the way in which you have borne the inconvenience that I at first subjected you to. I hope that the insight which you have here gained into some of the laws by which the universe is governed, may be the occasion of some amongst you turning your attention to these subjects; for what study is there more fitted to the mind of man than that of the physical sciences? And what is there more capable of giving him an insight into the actions of those laws, a knowledge of which gives interest to the most trifling phenomenon of nature, and makes the observing student find

> "——tongues in trees, books in the running brooks,
> Sermons in stones, and good in every thing."

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*Patent Steel Plates.** By DAVID LIVINGSTONE.

River Zambesi, East Africa, 12th January, 1860.

SIR:—The insertion of the following note in the *Journal of the Society of Arts* may prove of public service in preventing any other expedition trusting to a vessel built of the "patent steel plates," which have caused us so much toil, loss of time, and annoyance.

It is probable that there are purposes to which these patent steel plates might be applied with great advantage, but eighteen months experience in a steam punt constructed of this material, has proved that the substance cannot be trusted in tropical waters. Whatever may be the process by which the plates are converted into steel, a very remarkable decomposition soon takes place when exposed to the heat and moisture of this climate, and a considerable portion of the plate becomes what possibly is the black oxide of iron. In our case, the whole vessel was painted thoroughly, inside and outside, with Peacock's patent paint while on the deck of another vessel in the voyage out. But this proved no protection, for a process of decomposition began on both surfaces, altogether different from the common rust of iron. Scales of a jet black color were formed, and when detached the plates were found to be as smooth and black as if they had left the rollers but an hour before. The scales are black in their substance, too, and strongly magnetic. The paint, firmly adherent on the outer surface, showed that it had failed to prevent the process, and curiously enough, the rivets, which are probably of common steel, neither rusted nor decomposed. For a considerable time the process of scaling off and leaving a smooth, black, and even shining surface, made us believe that the plates were suffering no harm by exposure to the weather. Friction had no effect in wearing them. But the decomposition was going on at the same rate inside; blisters, also, were formed, and at the bottom of each there was a minute hole right through, and at the end of twelve months the removal of the internal surface scale left us with plates as thin as wafers, and so full of small holes our wretched craft might have been converted into a coffee strainer for the entire Society of Arts. The plates were only one-sixteenth of an inch in thickness at the beginning, and the internal scales are one-thirty-second of an inch. The framework being of the flimsiest contract style, any attempt at mending involving hammering or wedging would have been putting a new piece into an old garment, so we had to resort to puddling her with stiff clay. This served for a while, but the holes becoming too large, we were obliged to run down to the sea, and with the assistance of the tides, get her out of the water. By digging the sand from beneath, we reached the worst places, and the engineers, Messrs. Rae and Hill, assisted by men from H. M. S. *Lynx*, put planks outside and inside, with plies of canvass and white lead, sandwich fashion, and guaranteed her to float any time between three days and six weeks. New leaks, however, forced us to beach before the first period mentioned, and though rather annoyed at being kept tinkering, instead of doing good service to the cause of African civilization, we must, as we have often done with disagreeables before, "put up with it."

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* From the Journal of the Society of Arts, No. 406.

No advantage whatever has been gained by the employment of these steel plates. The contractor intended that by their use the vessel should draw thirteen inches only, but when we tried her fairly out here in salt water, without fuel, gear, crew, or water in the boiler, she drew twenty-three inches, and her paddle floats are, of course, ten inches too deep. It was promised that she could carry from ten to twelve tons, but four tons bring her down to 2 ft. 7 ins. and within a few inches of the paddle wheel shaft, while six tons would sink her altogether.

Nor have we gained the least in speed, for, instead of "ten knots, at least," promised, we have to be content with a top speed of 3¼. This may in part be owing to the peculiar form adopted—an imitation of the Niger canoes, *i. e.*, long, narrow, and turned up at the ends. The negro reasons for this shape are sensible enough. They cannot make them broader than the trees, and make up in length what they cannot have in breadth, and they are turned up at the ends to avoid the shock which would be felt in coming to a bank, were they not made to slide up. These reasons are not so very recondite as to induce us to forsake the wave line of Mr. Scott Russell surely. Here we often see canoes made out of crooked trees, and as they are simply hollowed out, the canoe retains the bends of the stock. Some future contractor, if using other people's money, may infer that these crooked canoes are exactly suited for turning round corners, instead of inferring that the owners had no straight trees near the river.

*On Foot Valves in Condensers and Air Pumps.**

The subject of foot valves in air pumps has, by engineers, been too much overlooked. It is of the greatest importance in marine engines, particularly in propeller engines, where the machinery is applied direct to the propeller shaft. Captain Carlsund, in Motala, I believe was the first engineer who paid attention to the proper arrangement in air pumps and foot valves; he applies his machinery with the air pump direct to the propeller shaft, making 100 to 140 revolutions per minute, and is found to work exceedingly well, while in America and England they have been obliged to gear the air pump down to a slower motion, or when attempting to apply it direct to direct action machinery, it has sometimes ended in a total destruction of the whole; the true cause of the blunder has been concealed and made over and over again.

The disproportion of foot valves has caused the loss of millions of dollars in America; for instance, the first engines on the frigate *San Jacinto*, U. S. N., broke down from the disarrangements of the air pumps. The *La Fayette's* engines, which I believe had the worst air pumps ever constructed for the purpose, broke down from the same cause; also, the *City of Petersburg*, and others, all American first-class steamers.

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* From the Lond. Artizan, Oct., 1860.

When the air pump is working, the water is forced through the foot valve by the pressure or the deficiency of vacuum in the condenser. Every pound of pressure per square inch balances a column of water of about 27 inches high; for instance, if the vacuum in the condenser is 24 inches of mercury, which is termed 12 pounds per square inch, and the atmospheric pressure being 14·75, then $14·75 - 12 = 2·75$ lbs., which will be the pressure per square inch in the condenser, and $2·75 \times 27 = 74·25$ inches, or 6·2 feet, the head, which presses the water through the foot valve into the air pump. According to the relative position of the condenser and air pump, there may be an additional head, as when the water level in the condenser is above the air pump piston.

I will here endeavor to give some formulæ, by which to determine the area of foot valves, and size of air pumps, which will be found to be of the greatest importance for propeller engines.

$D =$ diameter of steam cylinder in inches.
$S =$ stroke of piston in inches, double acting.
$d =$ diameter of air pump in inches.
$s =$ stroke of air pump piston in inches.
$a =$ area of foot valves in square inches.
$n =$ number of double strokes of the air pump piston per minute, when the air pump is applied direct to the engines.
$m =$ co-efficient for friction and resistance to the water in passing through the foot valve, estimated to 0·6 to 0·7.
$n =$ pressure in the condenser, or deficiency of vacuum in pounds per square inch.
$T =$ temperature of the exhaust steam, Fahrenheit's scale.
$k =$ specific volume of the exhaust compared with water.

Assuming the temperature of the condensing water 100°, and the injection water 50° Fahrenheit's scale, we shall have the following formulæ:

$$\left.\begin{array}{l} d = 0·326\, D \sqrt{\dfrac{S\,(890+T)}{k\,s}}, \\[2ex] s = 0·106\, D^2 \dfrac{S\,(890+T)}{k\,d^2}, \end{array}\right\} \text{Single acting air pumps.}$$

$$\left.\begin{array}{l} d = 0·231\, D \sqrt{\dfrac{S\,(890+T)}{k\,s}}, \\[2ex] s = 0·053\, D^2 \dfrac{S\,(890+T)}{k\,d^2}, \end{array}\right\} \text{Double acting air pumps.}$$

$$a = \frac{D^2\, S\, n\,(890+T)}{23{,}000\, m\, k \sqrt{p}} \text{ area of foot valve.}$$

By the last formula, it appears, the proper area of the foot valve is independent of the capacity of the air pump,—such is actually the case; if the foot valve is made too small the air cannot pump water enough for a good vacuum, however large it may be. It is most frequently the case in propeller engines that the air pump is too large and the foot valve too small.

Example.—A single acting air pump is to be constructed for an engine of

$D = 75{\cdot}75$ inches, the diameter of cylinder.
$S = 36$ inches, the stroke of piston.

Steam pressure to be 20 lbs. per square inch, expanded $\frac{1}{2}$; vacuum in the condenser to be 12·75 lbs., or $p = 2$; stroke of the air pump piston to be $s = 18$ inches. Required, the diameter of the air pump d, and area of the foot valve a?

Steam pressure, $20 + 15 = 35$ lbs.; expanded one-half $= 17{\cdot}5$ lbs., the pressure of the exhaust steam; temperature $T = 221°$, and $k = 1440$ the specific volume. The diameter of the air pump will be

$$d = 0{\cdot}326 \times 75{\cdot}75 \sqrt{\frac{36\,(890 + 221)}{1440 \times 18}} = 30{\cdot}64 \text{ inches.}$$

The air pump making $n = 45$ double strokes per minute, area of the foot valve will be

$$a = \frac{75{\cdot}75^2 \times 36 \times 45\,(890 + 221)}{23{,}000 \times 1440 \times 0{\cdot}64 \times \sqrt{2}} = 344 \text{ square inches.}$$

The dimensions in this example are similar to that of the engines in the line-of-battle ship *Rattvisan*, except the air pumps, are there 42 inches diameter, and area of the foot valve is only 273 square inches, while this example gives only 30·64 diameter, and 344 square inches of foot valve.

This, I believe, is an error in all the upright trunk propeller engines.

Referring to the *Artizan* for November, 1856, it will be found that the United States steam frigate *Merrimac* suffered the breaking down of her foot valves on her passage from America to England. The *Artizan* states that the original foot valves were only 176 square ins., that new ones were replaced of 230 square inches, while the frigate laid at Southampton, and that about one pound of vacuum was gained with the increased foot valve. Dimensions of the engines of the *Merrimac* are, diameter of cylinders 72 inches, stroke of piston 3 feet, diameter of air pumps 22 inches, stroke of air pump 3 feet double acting.

When, by this calculation and formulæ, the area of the foot valve becomes nearly the same size, or greater than the area of the air pump piston, the latter must be made double acting, and half the calculated area of the foot valve to be applied at each end of the air pump. In very high velocity the area of the foot valve may become greater than the area of the double acting air pump; in such cases it is necessary to make plungers, so that the section area of the space in which the plunger moves is greater than the area of the foot valve, and the operation will be rendered efficient.

*On Etching.**

Ornamentation on metals, glass, and porcelain, has come into considerable use; and, believing as we do, that such work would not only be pleasant to amateurs, but might also be useful to others, we think that a few brief and practical notes on the subject may not be out of place.

First, as regards copper plates—which in many respects have an advantage over steel for the use of amateurs,—procure a thin plate, properly polished on the surface, at any of the regularly established copper-smiths. These can be had of the size of several feet down to a few inches. The surface of the plate being bright and free from tarnish, remove all grease with great care by washing with spirit of turpentine and then rubbing with very fine whitening and wash-leather. Care must be taken not to scratch the plate.

Having got rid of all grease, fix a hand-vice to one corner or some other convenient part of the plate; it is then ready for the reception of the etching-ground—a preparation chiefly composed of asphaltum, pitch, and virgin wax; there is, however, a great art in making this sufficiently plastic, so as to admit of its being properly spread upon the plate when heated. It is better for ordinary purposes to purchase it at the copper-smith's or tool-shop, where a supply can be had for about one shilling. A dabber, for the purpose of laying the ground on the plate, is also necessary. This is of a mushroom shape, and composed outwardly of very fine silk or kid leather, free from grease; the inside is padded with wool. This can be readily made by any person who has seen one of them. In order to prevent any grit or impurity which may chance to be in the etching-ground, it is better to tie it in silk. For the purpose of heating the plate, a hot iron, or a spirit lamp, placed below an iron frame on which the plate may rest, or other contrivance may be used. Care is to be taken to make as little dust as possible. The metal must not be allowed to get too hot, for that would burn the etching-ground, and prevent it from sufficiently resisting the acid. The plate being of a proper heat, by drawing the etching-ground over the face, a small quantity will be lodged upon it. This in the first instance is uneven; but may be spread in a flat, thin, even manner. Every part must be covered by the ground, or else the acid would leave such places as are bare liable to be corroded into holes. The ground, when this is spread on the surface, is of a light brown color, so delicate that it is difficult to see any pencil outline which might be transferred, or properly to see the scratches made by the etching-needle. In order to darken this, it is necessary, while the plate and etching-ground are still warm, to smoke it by the flame of a wax taper or candle. The flame must be kept moving about, and not allowed to touch the plate so closely as to burn the ground.

These operations, although simple, require some little practice and experience; and it is, perhaps, a good plan either to take a lesson or two in ground-laying, and the other parts of this process, from an engraver, or else to get one of this profession to lay the ground and bite in the plate when etched.

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* From the Lond. Builder, No. 918.

The ground having been made ready and the plate cold, an outline of the subject, prepared on ordinary or tracing paper, should be damped and transferred by means of pressure. The best way to manage this is to take it to a copper-plate printer, who will do it effectually for a few pence; for those living in the country where such convenience cannot properly be had, this transfer can be made by one of the ordinary letter copying machines, or by going very delicately over the back of the outlines with a pencil or other instrument which is not too sharp.

This having been done by means of an etching-point, which can be had at the tool-makers, the design can be readily scratched upon the plate. Attention is needed to mark the lines quite through the ground. The hand should also be prevented from coming in contact with the ground, and all unnecessary scratches be carefully avoided. This may, to a considerable extent, be done, by forming a bridge of a flat ruler, supported by pieces of card-board or folded paper.

Wherever the etching-ground has been passed through by the etching-needle, that part is liable to be eaten into a line by the application of acid; on no other portion however, if properly done, should the acid work.

It being necessary to cover the etching with an even depth of diluted acid (from a quarter to half an inch), in order to produce equality in the *biting*, it is needed to form a wall of wax round the margin of the work. The best material for this is bees-wax with a small part of Burgundy-pitch added, and then the mixture boiled until the whole is well mixed. This, when needed for use, should be put into warm water, and then it can be readily raised round the plate and pressed down by the fingers, and after that more firmly by the handle of the etching-point, so that a sort of tank is formed, which will contain the acid as long as it may be necessary.

With the greatest care scratches may be made, or it may be necessary to erase parts, or the wax wall may not be sufficiently tight. In order to remedy this, turpentine-varnish, or the ordinary "Brunswick black" used for stoves, may be employed, thinned to a proper extent by turpentine, and applied with a black-lead pencil.

For the purpose of "biting in" the plate, as the engravers call it, nitrous acid of the purest description should be mixed—one part of acid and three parts water—which should be stirred up with a feather or pencil; soon the lines will be covered with minute globules; and, in proportion to the time the acid is allowed to remain, the etched lines will become thicker and deeper.

As a matter of course, in order to produce a delicate and refined effect a variety of thicknesses of line is desirable; and, although much can be done by the pressure of the point, by hatching, doubling lines, &c., it is in most cases necessary to allow the acid different times of action; for instance, it will be desirable to keep distant mountains and landscape thin, and to bring out the foreground by bold and deep lines. In order to manage this, the acid must be poured off into a vessel for further use, and then the plate must be well washed with clear water, and afterwards dried with a bellows or other means; then such parts of the etching as are of sufficient depth should be covered with the varnish in the same manner as the blemishes to which we have referred. This operation may be performed any number of times, each time washing and drying the plate; this must be also done when the biting is completed; and, then, by gently heating the back of the plate, the wall may be drawn off, and by means of a little spirit of turpentine and oil, the surface of the plate may be cleared of the etching-ground. There are other operations, such as re-biting, re-etching (by touching with the graver), and by working with a point without the use of acid, &c., &c.; these, however, would require much space to describe, and this we will not just now do, as it is more particularly our object in mentioning the above to make operations which might be useful in many manufactures more readily understood.

In the same manner, but with the use of different acids, and on any scale, etching may be applied to steel, iron, brass, glass, and, lately, we are told, to porcelain. For steel, nitric acid very largely diluted with pyroligneous acid until it does not taste much stronger than vinegar, is best. On brass we have seen diaper and other ornaments produced with great clearness and rapidity in the following manner. On large works, such as monumental brasses, experience has shown that in the biting, either by nitric or nitrous acid, before a great depth is got the biting of the lines is stopped by the formation of a black oxide, which it requires a very strong preparation of nitrous and sulphuric acid to remove and keep in solution; and this after a time proves too strong, and tears up the ordinary etching-ground; it has, however, been found that turpentine-varnish, if allowed for a few days to harden, has a great resistance; and by the use of this when diapers, &c., are outlined, the raised parts may be painted with the varnish; and, when hard, the acid applied; and it is astonishing what good effect may be produced by these means. Large surfaces for the relief of foliage, figures, letters, &c., may by this means, be executed with rapidity, either for filling in with colored shellac or pigments.

The painting of these ornamental plates with varnish might be the means of affording employment to females, and probably the preparation of embossing, and otherwise ornamenting glass to be bitten by fluoric acid, might also be brought into far more extensive use than it is at present, and would also provide a certain amount of respectable labor for females.

AMERICAN PATENTS.

AMERICAN PATENTS ISSUED FROM SEPTEMBER 1, TO SEPTEMBER 30, 1860.

Amalgamator,	G. M. Norton,	San Francisco,	Cal.	18
Amalgamators,—Quartz	Wm. H. and I. Scoville,	Chicago,	Ill.	25
Annealing Apparatus,	Joseph Worcester,	Newport,	Ky.	25
Apple Parer, Corer, and Slicer,	J. J. Parker,	Marietta,	Ohio,	11
Aqueducts,	John Osborn,	Mt. Carmel,	Conn.	4
Augers,	J. M. Hathaway,	City of	N. Y.	4
Axes to Handles,—Fastening	W. H. Livingston,	"	"	25
Barometer,	E. F. Hamann,	Collikoon,	N. Y.	18
Barrel-head Machine,	C. B. Hutchinson,	Auburn,	"	11

Bathing Tubs,—India-rubber	Ramsay & Wilson,	Grafton,	Va.	4
Bed Bottom Spring,	H. R. Crampton,	Lockport,	N. Y.	18
Bedstead,	B. S. Pringle,	Barnesville,	Ga.	4
———,—Folding Case	Ethan Whitney,	Lynn,	Mass.	18
———,—Spring	D. R. Lightner,	Bucyrus,	Ohio,	4
Beehives,	John Jacobs,	Columbus,	"	25
Beer,—Factitious	Ferdinand Luedke,	City of	N. Y.	25
Bending Wood,	Spaulding & Pierce,	Westminster,	Mass.	11
Billiard Tables,—Cushions for	H. W. Collender,	City of	N. Y.	25
Blowers,	P. H Roots,	Connersville,	Ind.	25
Boards,—Machine for Thinning	Sharon Case,	Lumpkin,	Ga.	4
Bolt,—Shutter	Augustus Reeve,	Allowaystown,	N. J.	18
Bombshells,	Wm. Rice,	Philadelphia,	Penna.	11
Bottles,—Forming Screws in	John Foeer,	Glassborough,	N. J.	18
Boots and Shoes,	J. M. Allen,	Fredericktown,	Ohio,	18
————,—Heel for	D. E. Somes,	Biddeford,	Me.	18
Boot and Shoe Soles,—Cutting	L. S. Graves,	Rochester,	N. Y.	18
Boxes,—Device for Joining	Wright Duryea,	City of	"	11
Brick Moulds,	Matthew Elder.	Lansing,	Mich.	11
Broom,	W. H. Towers,	City of	N. Y.	4
Buckwheat, &c.,—Cleaning	J. H. Reed	Penn Towns'p,	Penna.	4
Burglar Alarm,—Electro-mag.	Jacob Haller,	Ann Arbor,	Mich.	25
Candles,—Moulding	Antonio Meucci,	Richmond co.,	N. Y.	25
Cane Juice,—Sulphurous acid to	Thomas Byrne,	Baton Rouge,	La.	4
Carpet Lining,—Making	J. R. Harrington,	City of	N. Y.	11
Carriage Jack,	J. Card,	Cleveland,	Ohio,	25
Carriages,	Efner & Sperry,	Ann Arbor,	Mich.	4
———	Wicklin & Weaver,	Carlinville,	Ill.	4
———,—Extension,	J. A. Naylor,	Rahway,	N. J.	4
Cars from one track to another,	Wm. Wharton, Jr.,	Philadelphia,	Penna.	18
Cartridges,—Metallic	Ethan Allen,	Worcester,	Mass.	25
Cement,	P. A. Letourneur,	New Orleans,	La.	11
Chains,—Link for	G. W. N. Yost,	Yellow Springs,	Ohio,	11
Chair for Invalids,	Chas. Messenger,	Warren,	"	25
—— Seat,	L. B. Batcheller,	Rochester,	N. Y.	11
Cheese,—Pressing	Wm. McAllister,	Gerry,	"	4
—— Vats,	Wm. Ralph,	Holland Patent,	"	25
Clothes Frame,	S. T. Lamb,	N. Washington,	Ind.	18
———	Patrick Cody,	Hamilton,	N. Y.	25
—— Dryer,	H. E. Fickett,	Glenn's Falls,	"	4
———	O. P. Allen,	Rindge,	N. H.	11
Clock,—Calendar	T. T. Strode,	Mortonville,	Penna.	25
Coffee,—Cleaning, Drying, &c.	Wm. Newell,	Philadelphia,	Penna.	18
Compass Protractor,	F. H. West,	San Francisco,	Cal.	25
Condensation,—Apparatus for	Mihan & Lane,	Boston,	Mass.	18
Corn Planters,	W. G. Savage,	Clinton,	Ill.	25
———	John Underwood,	Cameron,	"	25
———	L. F. Straight,	Fairbury,	"	11
—— Shellers,	Michael Hauseman,	Huntingdon,	Ind.	4
——— and Cleaners,	J. C. Richards,	Lafayette,	"	25
Cotton Bales,—Iron Ties for	P. Davy,	Portsmouth,	Ohio,	25
————,—Metallic Bands	R. W. Fenwick,	Washington,	D. C.	25
—— Cleaners,	S. C. Ames,	Washington,	Ark.	11
————	Isaac Hayden,	Lawrence,	Mass.	11
————	Charles Smith,	Knoxville,	Texas,	11
—— Gins,	H. L. Emery,	Albany,	N. Y.	4
————,—Feeders for	S. Z. Hall,	Sequin,	Texas,	11
—— Scrapers,	J. C. Teague,	Center Hill,	Miss.	4
—— Seed,—Hulling	Joel Tiffany,	Syracuse,	N. Y.	18
——— Planters,	O. L. Gibson,	Fort Bend co.,	Texas,	11
Couplings,—Railroad Car	John McKinney,	Lansing,	Mich.	4
——— for City Railroads,	Collyear & Patterson,	Philadelphia,	Penna.	11

Cultivators,	T. E. C. Brinly,	Louisville,	Ky.	25
—— ——	Gilbert & Weston,	Starkville,	Ga.	4
—— ——	Wm. H. and L. Seymour,	Weymouth,	Ohio,	11
—— ——	J. F. Wood,	Houma,	La.	25
—— ——	G. W. N. Yost,	Yellow Springs,	Ohio,	4
—— ——,—Cotton	W. W. Golsan,	Autaugaville,	Ala.	4
—— —— ——	J. C. Sellers,	Woodville,	Miss.	25
Curtain Fixture,	J. F. Hall,	Bangor,	Me.	4
—— ——	J. C. Whitwell,	City of	N. Y.	25
Dental Chairs,—Construction of	Justus Ask,	Lyons,	N. Y.	4
Dividers,—Spring	J. W. Strange,	Bangor,	Me.	11
Door Latch,	Jonathan Walton,	Brooklyn,	N. Y.	11
Doors and Gates,—Closing	Stephen Stewart,	Philadelphia,	Penna.	11
Draw-bridges,—Self-acting	Schneider & Montgomery,	Williamsport,	"	4
Egg-beater,	H. F. Drott,	Cumberland,	Md.	18
—— ——	Nicholson & Earle,	Providence,	R. I.	25
Electro-magnets,	C. T. Chester,	City of	N. Y.	4
Electro-magnetic Apparatus,	Jerome Kidder,	"	"	18
Envelope,—Prepaid	J. B. Murray,	"	"	25
Excavating Machines,	M. B. True,	Newburyport,	Mass.	18
Faucets,	L. L. Alrich,	Carthage,	Mo.	25
——	Wm. Cleveland,	Orange,	N. J.	25
——	James Farnan,	Cleveland,	Ohio,	18
Fences,	Henry Burrows,	Georgetown,	D. C.	11
Fibrous Material,—Sheets of	Wm. Fuzzard,	Charlestown,	Mass.	18
Fire Arms,	C. F. Brown,	Warren,	R. I.	18
——,—Breech-loading	Ethan Allen,	Worcester,	Mass.	18
——,—Revolving	J. M. Cooper,	Pittsburgh,	Penna.	4
—— —— ——	Daniel Moore,	Brooklyn,	N. Y.	18
Fire-places,	C. A. Littlefield,	Covington,	Ky.	11
Floodgates,—Self-acting	G. B. Markham,	Mead's Mills,	Mich.	4
Flour,—Preparation of	Thomas Byrne,	Baton Rouge,	La.	4
Furnaces,	Mellen Battel,	Albany,	N. Y.	18
——	W. D. Thomas,	Morristown,	Vt.	4
——,—Bagasse	Jones & Charpentier,	New Orleans,	La.	18
——,—Hot-air	A. H. Bartlett,	Spuyten Duyvil,	N. Y.	18
Gas from Wood,—Making	August Schmidt,	City of	"	4
Gas Tubes,—Flexible	T. J. Mayall,	Roxbury,	Mass.	4
Gearing,—Machine	R. J. Gatling,	Indianapolis,	Ind.	18
Glass Jars,—Moulds for	R. Hemingray,	Covington,	Ky.	18
—— Moulds,	G. W. Scollay,	St. Louis,	Mo.	18
Grading Instrument,	S. L. Donnell,	S. Carroll,	Tenn.	11
Grain Cleaning Machine,	J. B. Tunison,	Ovid,	N. Y.	18
——,—Cleaning and Polishing	Plant & Raith,	St. Louis,	Mo.	18
—— Elevators,	T. H. Green,	Fon du Lac,	Wis.	4
—— Separators,	Moses Bugher,	New Philada,	Ohio,	18
—— —— ——	S. M. Wirts,	Hudson,	Mich.	11
——,—Separating & Scouring	D. S. Mackey,	Batavia,	N. Y.	18
——,—Sieves for Separating	H. W. Putney,	Lyons,	N. Y.	25
Grate Bars,	Daniel Lasher,	Brooklyn,	"	11
—— ——	W. W. Marsh,	Alton,	Ill.	18
Griddles,	G. W. Pittock,	Union Mills,	N. Y.	11
Gun Carriage,	J. J. Walsh,	City of	"	25
Harness,—Snap Hook for	John North,	Middletown,	Conn.	18
Harrows,	M. W. House,	Cleveland,	Ohio,	4
——	Stewart Neill,	Chillicothe,	Ill.	4
Harvester Cutters,	B T. Roney,	Philadelphia,	Penna.	11
Harvesters,	H. H. Foye,	Ottawa,	Ill.	25
—— ——	J. M. Long,	Hamilton,	Ohio,	4
—— ——,—Rake and Reel for	McClintock Young, Jr.,	Frederick,	Md.	18

Harvesters,—Raking Appa's for	W. A. Wood,	Hoosick Falls,	N. Y.	11
———————————	C. P. Gronberg,	Aurora,	Ill.	11
Harvesting Machines,	Bernhard Mertz,	Burlington,	Iowa,	11
Hatchways,—Opening & Clos'g	E. C. Ford,	City of	N. Y.	25
Hats,—Ventilating	Arthur Maginnis,	Philadelphia,	Penna.	11
Hay Elevating Forks,	L. A. Beardsley,	S. Edmeston,	N. Y.	11
—— Rakes,	C. J. Fay,	Hammonton,	N. J.	25
—— and Straw Cutters,	J. D. Felthousen,	Mich. City,	Ind.	18
———————	D. H. Whittemore,	Lynchburg,	Va.	4
Heating by Hot Water,	Hunter & Geissenhainer,	City of	N. Y.	18
Heating Buildings,—Appa's for	George Marlow,	Cincinnati,	Ohio,	11
Hemp Brakes,	R. J Gatling,	Indianapolis,	Ind.	4
————	Ives Scoville,	Chicago,	Ill.	25
Hops,—Preserving	J. C. Baldwin and others,	Waterville,	N. Y.	25
Horse Collars,—Hames for	Martin Drew,	St. Paul,	Minn.	18
Horse-powers,	Benjamin Bogue,	Trenton,	Iowa.	4
Horse Rakes,	Daniel Strock,	Chambersburg,	Penna.	11
Horses to Vehicles,—Attaching	Austin Avery,	S. Windham,	Conn.	18
Hose,—Waterproof	H. A. Alden,	Matteawan,	N. Y.	18
Hydrants,	Albert Fuller,	Cincinnati,	Ohio,	4
Jack Screws,	E. W. Cady,	Tomah,	Wis.	11
Journal Boxes,	P. S. Devlan,	Elizabethport,	N. J.	25
Lamps,	H. J. Batchelder,	Marlboro',	Mass.	18
———	George Neilson,	Boston,	"	18
——— or Torches,—Swinging	L. T. Pitkin,	Hartford,	Conn.	18
———,—Hanging Torch	C. H. Cooper,	City of	N. Y.	18
———,—Moulds for Glass	Joshua Jenkins,	Boston,	Mass.	18
Lifting Jack,	George Benjamin,	Avoca,	N. Y.	18
Lightning Rods,	David Wooster,	Seymour,	Conn.	4
Locks,	J. L. Hall,	Cincinnati,	Ohio,	25
———	C. F. Johnson and others,	Owego,	N. Y.	11
———	George Rosner,	Rochester,	"	18
———	E. P. Whitney,	Westfield,	"	4
Lock for Burglar-proof Pockets,	Wm. J. Scott,	Albany,	"	25
——,—Portable Door	E. G. F. Arndt,	Rondout,	"	18
Locomotive Engines,	A. J. Graham,	Portland,	Oregon,	4
——————,—Dischar.	John Greacen, Jr.,	City of	N. Y.	4
Looms,—Power,	Furbush & Crompton,	Worcester,	Mass.	4
Magneto-electric Apparatus,	H. N. Baker,	Binghampton,	N. Y.	4
Malt Kilns,—Floors for	Henry Franz,	Philadelphia,	Penna.	25
Manure Spreader,—Roller and	John Lyker,	Argosville,	N. Y.	25
Meat Cutter,	J. G. Perry,	S. Kingston,	R. I.	18
Medicinal Extracts,—Prepar. of	A. J. Despinoy,	Lille,	France,	18
Milk-straining Pails,	H. Buckins,	Canton,	Ohio,	18
Mills,—Fanning	B. F. Roe,	Nebraska City,	Nebr.	11
——,—Feeding Grain to	M. H. Ferguson,	Sunfish,	Ohio,	11
Mill-dams,—Waste Gates for	Sidney Hudson,	Milford,	Mich.	4
Millstones,—Balancing	D. Fellenbaum,	Lancaster,	Penna.	4
————,—Dressing	C. D. Brewer,	Lewisburg,	"	4
————,—Hanging	Z. McDaniel,	Bowling Green,	Ky.	11
Miter Box,	H. B. Nash,	Sandy Hill.	N. Y.	11
Mop Wringer,	C. S. Schmidt,	City of	"	25
Mortising Machines,	H. C. Smith,	Clarksville,	Ohio,	4
Motion,—Stopping & Changing	F. A. Pratt,	Hartford,	Conn.	4
Mowing Machines,	Henry Marcellus,	Amsterdam,	N. Y.	4
——————,—Hand	J. M. Spencer,	Enfield,	Me.	4
Ore Washer,	B. O'Bryan,	Lancaster,	Penna.	18
Paddle Wheel,—Stern	D. K. Peoples,	Philadelphia,	Penna.	18
Paper,—Trimming	Julius Koch,	S. Adams,	Mass.	4
Parasols,	Davis & Frost,	Watertown,	Conn.	25

Patterns,—Marking Waving	Albert Moffet,	Bristol,	Ohio,	4
Piles by Atmos. Pressure,—Driv.	W. S. Smith,	Trenton,	N. J.	4
Pipe,—Casting	Alfred Brady,	City of	N. Y.	18
Pipes,—Moulding Metal	Homer Parmalee,	Philadelphia,	Penna.	4
———,—Tapping Water	Jacob Drake,	City of	N. Y.	18
Planes,—Moulding	Chas. Fleming,	Ypsilanti,	Mich.	11
Planing Machine,	H. D. Stover,	City of	N. Y.	4
Planing Mouldings,	Wm. Rankin,	Providence,	Va.	11
Ploughs,	T. E. C Brinly,	Louisville,	Ky.	4
———	G. W. Cunningham,	Paris,	Mo.	25
———	H. J. Fraser,	Kansas City,	"	25
———	Walter Warren,	Penn Yan,	N. Y.	25
———	W. T. Zollickoffer,	Shelbyville,	Tenn.	25
———,—Mole	W. B. Atkinson,	Plymouth,	Ill.	18
—————	H. Bagley,	Tipton,	Iowa,	18
—————,—Capstans for	A. Little and others,	Decatur,	Ill.	11
Post Holes,—Earth Borers for	A. S. Ballard,	Mt. Pleasant,	Ind.	25
Potato Planters,	G. W. and J. J. Kersey,	Beartown,	Penna.	25
Presses,—Anti-friction	A. H. Emery,	City of	N. Y.	11
———,—Drop	M. and C. Peck,	New Haven,	Conn.	4
———,—Cotton	P. G. Gardiner,	City of	N. Y.	4
—————	W. T. Opie,	Scarboro,	Ga.	4
—————	Maximilian Wappich,	Sacramento,	Cal.	4
Projectiles,	J. W. Cochran,	City of	N. Y.	25
Propulsion,—Marine	L. B. Flanders,	Cleveland,	Ohio,	18
Propeller,—Marine	A. E. Harding,	Middletown,	"	11
Pumps,	Henry Pease,	Brockport,	N. Y.	11
———	G. C. Selfridge,	N. Greenfield,	"	4
Railroads,	B. F. Lee,	City of	N. Y.	11
Railroad Cars,—City	Joseph Harris, Jr.,	Roxbury,	Mass.	4
——— Frog,	J. M. Robb,	Charleston,	S. C.	25
—————,—Substitute for	Black & Ford,	Erie,	Penna.	25
——— Joints,	L. B. Tyng,	Lowell,	Mass.	11
——— Switch,	G. E. Beach,	Jersey City,	N. J.	25
Railroads,—Safety Guards for	Thomas Stewart,	Pittsburgh,	Penna.	11
Rakes,—Horse	J. C. Stoddard,	Worcester,	Mass.	11
Ranges and Stoves,	J. G. Treadwell,	Albany,	N. Y.	11
Reaping Machines,	W. S. Stetson,	Baltimore,	Md.	25
Reed Instrument,—Steam	G. G. Ray,	Boston,	Mass.	4
Refrigerator,	Kirby Spencer,	Minneapolis,	Ind.	25
Rice,—Cleaning	Silas Dodson,	San Francisco,	Cal.	25
——,—Polishing	Daniel Lombard,	Boston,	Mass.	4
——,—Scouring	"	"	"	4
Rifle Balls,—Moulds for	Lewis Evans,	Morgantown,	Va.	18
Rock-drilling Machines,	L. M. Gilmore,	Janesville,	Wis.	11
Ruffles,—Manufacture of	G. B. Arnold,	City of	N. Y.	25
Saddles,	J. H. Boyd,	Baltimore,	Md.	25
Saddle Trees,	S. E. Tompkins,	Newark,	N. J.	25
Sad Iron,	L. S. Chichester,	City of	N. Y.	4
Sails for Vessels,—Fore-and-aft	A. C. Tibbetts,	Rockland,	Me.	11
Salt,—Manufacture of Common	Thomas Spencer,	Syracuse,	N. Y.	25
Sap from Trees,—Collecting	E. W. Ormsbee,	Montpelier,	Vt.	4
Sap Conductors,	Homer Hecox,	Rutland,	N. Y.	4
Saw Clamp,	J. H. Dunbar,	Plymouth,	Conn.	11
—— Frames,—Wood	Wm. H. Livingston,	City of	N. Y.	18
—————	"	"	"	18
—— Grinding Machine,	Wm. Dougherty,	Philadelphia,	Penna.	25
—— Teeth,	Ira Mason,	Berlin,	N. H.	11
Saws,—Grinding	H. R. Burger,	Richmond,	Va.	11
——,—Handles to Cross-cut	Isaac Pelham,	Ithaca,	N. Y.	25
——,—Wood	Augustus Pruyn,	Albany,	"	11
Sawing Machine,—Hoop	Joseph Raub,	Highland,	Penna.	11

Sawing Out Shingles,	J. R. Hall,	Brunswick,	Me.	11
School Desk,	Amos Chase,	N. Weare,	N. H.	11
School Desks,—System of	S. L. Wilkinson,	Cross Plains,	Tenn.	18
Seed Planters,	W. H. Barber,	Wolcottville,	Conn.	4
———	W. W. Golsan,	Autaugaville,	Ala.	4
———	A. F. Hines,	Washington,	D. C.	4
Seeding Machines,	Ball & Nauman,	Dayton,	Ohio,	25
———	Benjamin Barnard,	Farmington,	"	25
———	David Eldred,	Monmouth,	Ill.	25
———	A. R. Park,	Columbia,	Texas,	4
Sewing ———	G. B. & A. Arnold,	City of	N. Y.	25
———	Dwight Tracy,	Worcester,	Mass.	11
———	T. S. Washburn,	Rochester,	N. Y.	11
Sheathing Ships, &c.,	John Revere,	Boston,	Mass.	4
Shingles,—Sawing	August Pernot,	Chilton,	Wis.	4
Ship-building,	S. L. Pionnier,	City of	N. Y.	4
Ships Air Ports,	Maupin & Rooke,	Portsmouth,	Va.	18
——— Windlass,—Vertical	Charles Perley,	City of	N. Y.	11
Shirt Bosoms,	Ira Perego, Jr,	"	"	25
Shirting,—Evening the Edges of	A. T. Underhill,	"	"	11
Shoe Lasts,	Franklin Maynard,	Cambridge,	Mass.	25
Skates,	Luther Fogg,	Boston,	"	4
Smoothing Iron and Lamp,	Leonard Bricker,	Springfield,	Ill.	11
Smut Machines,	H. W. Shipley,	Mt. Vernon,	Ohio,	11
——— and Scouring Machines,	James White,	Cleveland,	"	25
Sowing Machines,	J. L. Garlington,	Snapp'g Shoals,	Ga.	25
———	W. D. Mason,	Jarratt's Depot,	Va.	4
Spoke-shave,	Samuel Leonard,	Bridgewater,	Mass.	18
Staves,—Jointing	Wm. Robinson,	Augusta,	Ga.	11
———,—Riving and Dressing	"	"	"	11
Stables for Horses, &c.,—Safety	Wm. E. McIntire,	Salem,	Mass.	18
Stave Jointer,	Edmund Greenlee,	Summerhill t'p,	Penna.	11
——— Machines,	S. F. Gelston and others,	Buffalo,	N. Y.	25
Steam Boilers,—Grates for	F. A. Hull,	Belvidere,	Ill.	11
——— Engines,	Wallace Wells,	City of	N. Y.	11
———,—Cut-off valves	George Frost,	Brooklyn,	"	25
———,—Governors for	S. H. Miller,	Hanoverton,	Ohio,	11
———,—Oscil. Valves	George Burnham,	Pittsburgh,	Penna.	25
——— Hammers,	Thomas Beach	Freeport,	"	4
——— Heating Apparatus,	C. A. Wilson,	Cincinnati,	Ohio,	4
Steel,—Converting Iron into	E. G. Pomeroy,	City of	N. Y.	4
———	Thomas Sheehan,	Dunkirk,	"	4
Stench Trap for Sinks,	Alfred Carson,	City of	"	25
Stirrups,	D. W. Clark,	Stratford,	Conn.	11
Stoves,	W. B. Treadwell,	Albany,	N. Y.	18
———,—Cooking	Zebulon Hunt,	Hudson,	"	25
———,—Fruit Dry'g	D. C. Colby,	Newport,	N. H.	18
Stove Grate,	J. W. Parnell,	Troy,	N. Y.	25
Straw Cutters,	Wm. B. Kern,	Middlebourne,	Va.	18
———,—Feeder for	Daniel Fasig,	Rowsburg,	Ohio,	4
Street Paving,—Rammer for	Wm. Beach,	Philadelphia,	Penna.	18
Sugar-cutting Machine,	Charles Kingler,	City of	N. Y.	25
Sugar,—Refining	H. G. C. Paulsen,	"	"	18
Swifts,	M Hemingway,	Watertown,	Conn.	18
Scythes,—Hardening	Holman & Kelly,	Slaterville,	R. I.	18
Tanning,—Apparatus for	Wm. H. Heald,	Baltimore,	Md.	11
Teaching Children,	J. J. Johnston,	Alleghany,	Penna.	4
Thread-dressing Machines,	Julius Loeb,	City of	N. Y.	11
Threshing Machines,	David Barger,	Columbia,	"	11
———	A. B. Crawford,	Piqua,	Ohio,	4
Tiles,—Blocks for Forming	James Molyneux,	Bordentown,	N. J.	11
Tobacco,—Straightening, &c.,	W. W. Justis,	Genito,	Va.	11

Toilet,—Composition for	Sampson American,	Chicago,	Ill.	11
Treadle Connexion for Machin'y,	A. A. Raymond,	Salem,	Mass.	11
Trip Hammer,	Alexander Morton,	City of	N. Y.	18
Tuck and Plait Folders,	Reuben Brady,	"	"	4
Turning Ovals,—Machines for	I. S. Barber,	"	"	4
Umbrella Sticks,—Wood for	Jonathan Ball,	Elmira,	N. Y.	4
Valves,—Slide	James Millholland,	Reading,	Penna.	25
——— ———	John Randall,	Elmira,	N. Y.	25
Veneers,—Chamfering	George Williamson,	Newark,	N. J.	4
Vulcanized Rubber,—Restoring	D. D. Parmelee,	Salem,	Mass.	25
Wash-board,	A. Hoagland,	Jersey City,	N. J.	11
Washing Machine,	S. W. Mudge,	Rome,	N. Y.	18
——— ——— ———	Wm Shafer,	Ripon,	Wis.	11
——— ——— ———	C. D. and S. M. Ober,	Morrisville,	Vt.	11
Watches,	E. G. Elliot,	Elk Horn,	Wis.	11
Wells, &c.,—Rais'g Water from	Joel Lee,	Galesburg,	Ill.	18
Wheels,—Car	Wade & Kaye,	Pittsburgh,	Penna.	4
———,—Tightening Tires on	Everett Bass,	Calhoun co.,	Ga.	11
Whiffle-trees for Vehicles,	M. C. Chamberlin,	Johnsonsburg,	N. Y.	11
Windmills,	J. R. Babcock,	Canandaigua,	"	18
Window Sashes,—Hanging	L. W. Thickstun,	Chatfield,	Minn.	18
——— ——— Shutter Stands,	J. W. Knapp,	Chester,	N. Y.	4
Wine Presses,	Wm. S. Kimball,	Rochester,	"	4
Wood-screws,	George Freeman,	City of	"	11

EXTENSIONS.

Acids,—Separat. Oleic & Stearic	J. S. Gwynne,	City of	N. Y.	4
Sewing Machines,	Elias Howe, Jr.,	Brooklyn,	"	11
Stoves,	J. H. B. Latrobe,	Baltimore,	Md.	4

ADDITIONAL IMPROVEMENTS.

Corn Planters,	W. C. Banks,	Como Depot,	Miss.	4
Hay,—Loading	T. J. Jolly,	Olean,	Ind.	4
Stoves,	G. J. Kingsbury,	Rochester,	N. Y.	18

RE-ISSUES.

Bags,—Making Paper	E. W. Goodale,	Clinton,	Mass.	4
Cameras.—Plate-holder for	A. S. Southworth,	Boston,	"	25
Cloth,—Drying	B. Sexton,	E. Windsor,	Conn.	25
Cordage,—Manufacturing	Wm. Joslin,	Cleveland,	Ohio,	25
Grain Separators,	J. L. Booth,	Rochester,	N. Y.	25
Hay Making Machines,	J. C. Stoddard,	Worcester,	Mass.	11
Lamps,	M. A. Dietz,	Brooklyn,	N. Y.	4
———	Wm. Fulton,	Cranberry,	N. J.	25
———.—Vapor	A. M. Mace,	Springfield,	Mass.	4
Ovens,—Bakers	Hiram Berdan,	City of	N. Y.	11
Printing Presses,—Feeding	S. and G. H. Ferguson,	Malden Bridge,	"	25
Ploughs,—Gang	Henry Cowing,	Corpus Christi,	Texas,	11
Railroads,—Sleeping Cars for	Eli Wheeler,	Elmira,	N. Y.	18
Roofing Compositions,	Henry Lester,	Cincinnati,	Ohio,	18
Seed Planters (5 Patents),	G. W. Brown,	Galesburg,	Ill.	11
Steam Engines,—Regulat. Valve	N. C. Travis and others,	Alton,	"	25

DESIGNS.

Sad Irons,	Thomas Loring,	Blackwoodt'n,	N. J.	25
Stove,—Plates of a	Horton & Martine,	Philadelphia,	Penna.	25
——,———— Cylinder	"	"	"	25
——,—Cooks	W. W. Stanard,	Buffalo,	N. Y.	25
———	"	"	"	25
Stoves,	N. S. Vedder,	Troy,	"	4
Washington Irving,—Medallion	Marie L. Livingston,	City of	"	4

FRANKLIN INSTITUTE.

Proceedings of the Stated Monthly Meeting, November 15, 1860.

John C. Cresson, President, in the chair.

John Agnew, Vice-President,
Isaac B. Garrigues, Recording Secretary, } Present.

The minutes of the last meeting were read and approved.

Letters were read from Eli W. Blake, Esq., New Haven, Conn.; and Jos. Wharton, Esq., Bethlehem, Penna.

Donations to the Library were received from the Royal Institution, the Royal Astronomical Society, and the Zoological Society, London; the Literary and Philosophical Society, Liverpool, England; the K. K. Geologischen Reichsanstalt, the K. K. Geographischen Gesellchaft, and the Oesterreichischen Ingenieurs Verienes, Vienna, Austria; Frederick Emmerick, Esq., Washington, D. C.; the Providence Athenæum, Providence, R. I.; Samuel Clark, Esq., City of New York; Henry Howson, Esq., and Prof. John F. Frazer, Philadelphia.

The Periodicals received in exchange for the Journal of the Institute, were laid on the table.

The Treasurer's statement of the receipts and payments for the month of October was read.

The Board of Managers and Standing Committees reported their minutes.

Eight resignations of membership in the Institute were read and accepted.

Candidates for membership in the Institute (14) were proposed, and the candidates proposed at the last meeting (18) duly elected.

Blake Brothers sent a cut and description of their Ore and Stone Breaker, with an invitation to the members to witness its operation at a quarry near Germantown. It consists of a heavy cast iron frame, carrying a movable hinged jaw, operated by a toggle-joint which takes its motion from a lever and a crank of short throw. Every revolution of the crank gives about one-quarter of an inch motion to the end of the jaw, which hangs nearly vertical, and so as to form, in connexion with the frame, a chamber for the reception of the stone. The size of this chamber varies with the size of the machine, being at the top from 10 ins. long by 5 ins. wide, to 20 ins. long by 7 ins. wide; whilst the bottom area, or exit for the broken stone, has the same length as the top, but of such width as may be desired to produce stone of the required size; the adjustment being made by a wedge and screw, or by substituting longer or shorter bars in the toggle-joint.

"The product of these machines per hour, in cubic yards, of fragments, will vary considerably with the character of the stone broken. Stone that is granular in its fracture, like granite and most kinds of sandstone, will pass through more rapidly than that which is more compact in its structure. The kind of stone being the same, the product per hour will be in proportion to the width of the jaws, the distance between them at the *bottom*, and the speed.

"The proper speed is about 200 revolutions per minute; and to make good road metal from hard compact stone, the jaws should be set from 1¼ to 1½ ins. apart at the bottom. For softer and for granular stones they may be set wider."

The following table will give an idea of the capacity of the breaker.

Size of chamber at top.	Product per hour.	Power required.
10″ × 5″	3 cubic yards.	6 horses.
15 × 5	4½ "	9 "
20 × 7	6 "	12 "

These machines are in use at the Central Park and new Reservoir, N. Y., Cooper & Hewitt's blast furnace, and at Graff, Bennett & Co.'s, Pittsburgh, and are said to give satisfaction in all cases.

Mr. Joseph Wharton, of the Lehigh Zinc Works, sent an ingot of pure Zinc for the inspection of the members. The ore from which it was made is obtained from the mines of the Lehigh Zinc Co., near Bethlehem, Penna., at which town the works are located. About 30 tons of metal are produced weekly, and when the furnaces are all in operation the production will be increased to two thousand tons per annum. All the articles required in the manufacture of the zinc are made upon the premises: as retorts, muffels, fire-bricks, &c., of ingredients brought from the surrounding country, no foreign material being used. This zinc is claimed to be equal to the best distilled zinc sold by manufacturing chemists. Prof. Booth, U. S. Mint, Prof. Bruel, Yale College, Mr. C. W. Eliot, and Mr. F. W. Storer, have examined and approve its quality.

A Rain Conductor, taken from the Farmers Market, was placed upon the table. Several of the conductors attached to the Market were, shortly after a heavy rain storm, found to be collapsed. This may have been owing to a sudden stoppage of the conductors near the top by shavings, and the consequent formation of a vacuum by the discharge of the water below the obstruction. Or, the water in falling through the conductor has, in obedience to the law of gravity, become attenuated more and more as it neared the ground, whilst the air has been carried along with its current, causing a partial vacuum, which the material of the conductor was not able to withstand. As a parapet wall surrounds the roof, a head of water was above the entrance to the conductors, and consequently no air could enter to supply the place of that drawn off, and a collapse resulted. The remedy would have been—perforations at intervals.

The President, at the request of the Committee on Meetings, gave an account of two remarkable instances illustrating the tendency of electrical discharges to disperse in different directions, when conducting bodies situated near its path are presented.

One of these was that of the destruction of several panels of a post and rail fence, on the farm of Israel W. Morris, situated near the western part of the city. The lightning appeared to have struck a maple tree standing on a small knoll in the line of the fence, and descending along the bark of the tree, without apparent injury, to the level of the rails near the ground, diverged in opposite directions along the fence, splitting the rails and bursting open the posts for the distance of eight panels each side, where it seems to have been conveyed into the earth.

The other case was that of a stroke of lightning on the line of telegraph belonging to the City Gas Works. In this instance, the flash was seen to dart upon a cherry tree standing about 60 feet south of the line of wires, and then to pass along the line in opposite directions, having the appearance of balls of fire leaping from pole to pole. The portion of the charge passing eastward was traced for the distance of 1500 feet by the destruction of the poles, many of which were so shattered as to let the wires drop to the ground, and others splintered more slightly. Going west, the poles were uninjured, the charge reaching the ground in that direction through the ground wire and the lightning protectors of the instruments at the First Ward station of the Gas Works, distant about 3100 feet from the point of reception. The instruments that were connected with the line were uninjured, but others which were not connected were greatly damaged; the copper wires being fused, and the glass case covering one of them shattered as if by an explosion from within.

The instruments referred to by the President were placed on the table for inspection by the members.

METEOROLOGY.

The Meteorology of Philadelphia. By James A. Kirkpatrick, A.M.

October.—The temperature of October was over four degrees higher than that of October, 1859, and about half a degree above the average temperature of the month for the last ten years. The warmest day of the month was the 2d, of which the mean temperature was 69°, and the thermometer reached the maximum (79°) on the same day. The 14th of the month was the coldest day, the mean temperature being 43½°. The temperature was lowest (36°) on the night of the 14th, during a storm of rain. On the same day, on the north of the city, and throughout northern Pennsylvania and southern New York, the first snow of the season fell. On the 15th, 16th, and 17th, the temperature increased gradually, and from the 18th till the end of the month, remained at about an average of 57°, with but little range, at no time being below 44°.

Both the daily oscillation and the mean daily range of temperature were less than for the same month last year, though they were slightly above the average for ten years.

The force of vapor and the relative humidity were above the average for the first time since last May; the increase in the former being more marked at 9 P. M., and in the latter at both 2 and 9 P. M.

Rain fell at Philadelphia on thirteen days of the month, to the aggregate depth of 4·685 inches, which is nearly two inches above the average for the month, and an inch and a half more than fell in October, 1859. It is more than fell in any other October for the last ten years; the nearest approach to the amount was in October, 1853, when 3·47 inches fell.

The pressure of the atmosphere was two-hundredths of an inch greater than the average, and nearly one-tenth of an inch greater than in October, 1859. The barometric column stood highest on the morning of the 1st of the month, when it indicated 30·275 inches, though the average height for a day was greatest on the 28th. It was lowest (29·312 inches) on the afternoon of the 8th.

There was but one day of the month on which the sky was completely clear, or free from clouds; and there were six days on which the sky was completely covered with clouds, at the hours of observation.

The winds during the month were but one degree nearer the west than in September, and still very nearly as far south of west as the resultant for the month for the last ten years is north of west.

The earthquake which extended throughout Canada and over all of the Eastern States, on the morning of Wednesday, the 17th of October, was not felt, or, at any rate, not noticed, at Philadelphia.

A Comparison of some of the Meteorological Phenomena of October, 1860, *with those of October*, 1859, *and of the same month for ten years, at Philadelphia.*

	Oct., 1860.	Oct., 1859.	Oct., 10 years.
Thermometer.—Highest, . .	79°	81·5°	90°
" Lowest, . .	36	30·0	28
" Daily oscillation,	16·10	18·10	15·60
" Mean daily range,	5·80	5·90	5·60
" Means at 7 A. M.,	51·58	46·98	50·97
" " 2 P. M.,	63·29	59·11	63·03
" " 9 P. M.,	55·61	50·87	55·17
" " for the month,	56·83	52·32	56·39
Barometer.—Highest, . .	30·275 in.	30·193 in.	30·410 in.
" Lowest, . . .	29·312	29·470	29·012
" Mean daily range, .	·119	·140	·143
" Means at 7 A. M., .	29·963	29·864	29·937
" " 2 P. M., .	29 906	29 823	29 895
" " 9 P. M., .	29·938	29·850	29 915
" " for the month,	29·936	29·845	29·916
Force of Vapor.—Means at 7 A. M.,	·321 in.	·259 in.	·312 in.
" " " 2 P. M.,	·363	·274	·344
" " " 9 P. M.,	·354	·280	·316
Relative Humidity.—Means at 7 A. M.,	80 per ct.	75 per ct.	78 per ct.
" " " 2 P. M.,	61	50	56
" " " 9 P. M.,	77	69	73
Rain, amount in inches, . .	4·685	3·210	2·781
Number of days on which rain fell, .	13	7	9
Prevailing winds, . . .	s.75°58′w·069	n.75°21′w·405	n.73°32′w·255

Abstract of Meteorological Observations for September, 1860; made in Philadelphia, Franklin, and Somerset Counties, Pennsylvania, for the Committee on Meteorology of the Franklin Institute.

1860.	PHILADELPHIA.—Lat. 39° 57′ 28″ N. Long. 75° 10′ 28″ W. Height above the sea 50 feet. Prof. J. A. KIRKPATRICK, Observer.									CHAMBERSBURG, Franklin Co. Lat. 39° 58′ N. Long. 77° 45′ W. Height 618 ft. WM. HEYSER, Jr., Obs.							SOMERSET, Somerset Co. Lat. 40° N. Long. 79° 3′ W. Height 2195 feet. GEO. MOWRY, Observer.						
	Barometer.		Thermometer.			Force of vapor.	Relative humidity.	Rain.	Prevail'g winds.	Barom	Thermom.		Force of vapor.	Relative humidity.	Rain.	Prevail'g winds.	Barom	Thermom.		Force of vapor.	Relative humidity.	Rain.	Prevail'g winds.
Sept.	Mean.	Mean daily range.	Mean.	Daily oscillation.	Mean daily range.	2 P.M.	2 P.M.			Mean.	Mean.	Mean daily range.	2 P.M.	2 P.M.			Mean.	Mean.	Mean daily range.	2 P.M.	2 P.M.		
	Inch.	Inch.	°	°	°	Inch.	Per ct.	Inches.	Direc.	Inch.	°	°	Inch.	Per ct.	Inch.	Direc.	Inch.	°	°	Inch.	Per ct.	Inch.	Direc.
1	29·817	·125	71·0	22	4·2	·459	46		N W.	29·216	66·7	4·0	·385	52		W.	27·678	60·3	5·7	·408	50		W.
2	30·087	·270	65·8	20	5·2	·307	38		N W.	29·447	63·0	3·0	·398	56		(var.)	27·831	59·3	4·3	·442	54		W N W
3	30·152	·065	68·2	18	2·3	·396	44		(var.)	29·541	68·3	5·3	·449	61		E.	27·895	63·7	6·3	·448	61		S E.
4	30·160	·071	70·0	25	2·8	·445	43		(var.)	29·507	70·3	2·0	·581	72		E.	27·870	66·0	1·7	·567	67		S E.
5	30·017	·143	75·3	20½	5·3	·617	53		S S W.	29·368	73·0	3·3	·677	66		E.	27·791	68·7	4·0	·771	78		S W.
6	29·974	·043	75·3	14	2·0	·700	66	0·072	S S W.	29·331	73·0	3·3	·744	86	0·575	E.	27·770	73·3	4·7	·772	71		E S E.
7	29·953	·025	78·5	20	3·2	·743	58		S W.	29·300	74·3	2·7	·772	80		E.	27·756	74·7	1·3	·826	70	0·027	S W.
☾ 8	29·755	·198	80·3	21	2·2	·822	56	0·032	S W.	29·138	77·0	2·7	·816	75	1·180	(var.)	27·629	73·0	2·3	·859	79	1·372	W.
9	29·910	·173	62·8	18	17·5	·313	47		N.	29·379	63·3	13·7	·330	53		(var.)	27·741	52·3	20·7	·281	58		N.
10	29·934	·079	62·7	24	5·5	·348	47		S W.	29·287	60·7	6·7	·389	63		W.	27·691	56·0	9·7	·455	63		W.
11	29·812	·122	63·7	10	4·3	·435	68	0·165	N E.	29·175	63·3	3·0	·398	56		(var.)	27·627	55·7	2·3	·366	52	0·375	W.
12	29·783	·115	55·7	12	8·0	·224	43	0·127	N W.	29·274	53·0	10·7	·225	57		(var.)	27·718	46·7	9·0	·270	72		N W.
13	30·051	·268	57·8	22	5·8	·240	36		N W.	29·500	56·0	3·7	·314	53		W.	27·896	47·7	4·3	·295	59		N W.
14	30·252	·201	63·5	25	5·7	·325	39		S W.	29·634	58·3	3·0	·425	64		S E.	27·975	55·0	10·0	·468	50		S E.
● 15	30·228	·029	66·0	24	2·5	·455	47		S W.	29·554	62·7	3·7	·459	58		S E.	27·948	60·3	5·0	·491	53		?
16	30·017	·211	68·8	24	2·8	·504	48		S W.	29·572	66·7	4·0	·601	65		E.	27·761	66·0	5·7	·526	57	0·221	S W.
17	29·894	·123	70·5	16	5·7	·587	68		S S W.	29·246	65·7	6·3	·577	84	0·085	(var.)	27·679	60·0	6·0	·462	65		S E.
18	29·972	·078	72·7	20½	2·5	·556	54		S W.	29·335	67·0	2·7	·608	80	0·210	E.	27·723	63·7	4·3	·581	71		S S E.
19	29·955	·025	74·7	18	2·0	·619	59		S E.	29·265	71·0	4·0	·704	81		S E.	27·697	67·0	3·3	·594	63		S S E.
20	29·682	·273	74·3	14	1·7	·769	78	2·056	S W.	29·064	71·3	1·7	·704	81	2·477	W.	27·535	62·3	6·7	·534	59	0·108	(var.)
☽ 21	29·871	·188	60·7	17	13·7	.260	41		WNW	29·273	58·7	12·7	·427	77		(var.)	27·681	49·3	13·0	·282	54		W.
22	30·073	·202	60·8	22	4·8	·280	38		S W.	29·380	57·0	7·7	·303	46		(var.)	27·767	55·0	9·7	·370	49		S W.
23	30·004	·069	68·7	23	7·8	·502	51		S W.	29·345	65·0	8·0	·505	56		W.	27·776	62·7	7·7	·518	60		W.
24	29·936	·068	69·7	22	1·3	·445	43		(var.)	29·222	66·0	2·3	·532	63	0·374	W.	27·650	64·3	2·3	·520	55		W S W
25	29·676	·260	70·8	15	2·8	·556	54	0·085	S W.	29·051	67·7	1·7	·462	55		W.	27·536	64·7	3·7	·614	68	0·058	W.
26	29·992	·316	60·3	14	10·5	·282	44		W.	29·416	60·7	7·0	·314	53		E.	27·831	49·0	15·7	·309	60		W.
27	30·135	·143	51·5	10	8·8	·293	73	0·370	W.	29·464	52.7	8·3	·375	93	0·234	(var.)	27·821	45·0	6·0	·273	84	0·409	S E.
28	30·034	·123	55·8	18	5·3	·281	47		N W.	29·436	54·7	3·7	·297	55		E.	27·812	48·3	6·0	·242	52		N W.
○ 29	30·232	·198	50·3	17	5·5	·161	35		N W.	29·591	48·7	5·3	·295	68		E.	27·921	44·0	7·0	·254	53		S W.
30	30·304	·072	48·3	10	3·3	·187	49		N W.	29·637	48·0	2·7	·308	79		E.	27·920	41·7	11·7	·221	83		E.
Means	29·989	·143	65·8	18	5·2	·437	50	2·907	s 74° w	29·357	63·5	5·0	·480	66	5·135	s 45° e	27·764	58·5	6·7	·465	62	2·570	s 63° w

Abstract of Meteorological Observations for September, 1860; made in Adams, Dauphin, Northumberland, Centre, and Erie Counties, Pennsylvania, for the Committee on Meteorology of the Franklin Institute.

1860.	Gettysburg, Adams Co. Lat. 39° 49′ N. Long. 77° 18′ W. Ht. 624 ft. Prof. M. Jacobs, Obs.					Harrisburg, Dauphin Co. 40°16′, N. 76°50′, W. Ht., 300 ft. John Heisely, M.D., Obs.					Shamokin, Northumberland Co. 40° 45′ N. 76° 30′ W. Height, 700 ft. P. Friel, Obs				Fleming, Centre Co. 40° 55′ N. 77° 53′ W. Ht., 780 feet. S. Brugger, Obs.				Erie, Erie Co.—Lat. 42° 8′ N. Long. 80° 12′ W. Height about 640 feet. Benjamin Grant, Obs.						
	Barom	Thermom.				Barom	Thermom.				Thermom.				Thermom.				Barom	Thermom.					
Sept.	Mean.	Mean.	Mean daily range.	Rain.	Pre-vail'g winds.	Mean.	Mean.	Mean daily range.	Rain.	Pre-vail'g winds.	Mean.	Mean daily range.	Rain.	Pre-vail'g winds.	Mean.	Mean daily range.	Rain.	Pre-vail'g winds.	Mean.	Mean.	Mean daily range.	Force of Vapor. 2 P. M.	Relative humidity. 2 P. M.	Rain.	Pre-vail'g winds.
	Inch.	°	°	Inch.	Direc.	Inch.	°	°	Inch.	Direc.	°	°	Inch.	Direc.	°	°	Inch.	Direc.	Inch.	°	°	Inch.	Per ct.	Inch.	Direc.
1	29·405	65·3	4·7		N W.	29·662	70·7	3·0		N W.	59·0	11·0		(var.)	62·0	4·3		(var.)	29·453	63·3		·440	64		N W.
2	29·645	63·7	3·0		N E.	29·945	66·7	4·0		N.	57·3	1·7		E.	58·7	5·3		W.	29·518	61·7	1·7	·408	60		E.
3	29·754	66·3	2·7		(var.)	30·046	69·7	3·7		E.	63·3	6·0		S E.	63·0	6·3		S W.	29·508	65·7	4·0	·537	61		S.
4	29·698	66·3	0·7		S S W.	30 008	72·3	3·7		(var.)	66·0	5·3		(var.)	68·0	8·3	0·050	S W.						0·110	S.
5	29·544	75·0	9·0		S S W.	29 857	78·0	5·7		(var.)	73·7	7·7	0·121	(var.)	74·0	6·0		W.							S.
6	29·533	73·0	4 0	0·095	S.				0·497	(var.)	74·0	2·3		E.	73·0	3·7	0·575	W.	29·349	75·7		·741	70	} 0·70	W.
7	29·499	76·3	3·3		(var)	29·772	78·7			S W.	73·3	3·3		S E.	73·3	3·0		(var.)							N.
☾ 8	29·338	77·7	2·0	1·060	(var.)	29·614	80·3	3·7		S W.	76·0	3·3	0·304	W.	71·3	5·3	0·410	W.							
9	29·519	57·7	20·0		N.	29·803	63 7	16·7		N.	57·3	18·7		W.	54·3	17·0		N W.							
10	29·488	57·7	7·3		S S W.	29·779	62·3	4·0		S W.	55·0	7·7		(var.)	56·3	9·3		S E.							
11	29·383	61·3	3·7	0·025	S W.	29·670	60·0	3·7		S W.	60·0	6·3		W.	57·7	7·3	0·220	N W.				·445	56		N.
12	29·466	52·3	9·0		N W.					N W.	49·3	10·7	0·400	W.	52·7	6·3		N W.	29·438	52·7		·214	36		N.
13	29·700	54·3	4·7		N W.	29·942	60·7			N W.	51·7	8·3		W.	52·0	1·3		N W.	29·579	55·7	3·0	·323	47		W.
14	29·841	57·3	5·7		S W.	30·107	62·7	2·7		S W.	54·0	9·0		W.	55·7	7·7		W.	29·562	66·0	10·3	·298	45		W.
● 15	29·777	61·3	4·0		S.	30·054	66·7	4·0		S W.	59·3	5·3		(var.)	58·0	2 3		(var.)	29·460	73·3	7·3	·431	55		S W.
16	29·548	66·7	4 7		(var.)	29·832	70·7	4·0		S W.	67·7	8·3		S E.	63·0	9·0		W.	29·256	68·7	6·0	·534	61		S W.
17	29·482	65·3	7·3		S S W.	29·727	69·7	6·3		(var.)	62·7	10·7		E.	64·0	5·7	0·185	S W.	29·313	61·7	7·0	·426	55		N.
18	29·536	69·3	4·0	0·165	(var.)	29·810	70·0	5·0		N E.	69·3	12·3	0·183	E.	65·3	5·3		(var.)	29·321	61·7	3·3	·479	58		(var.)
19	29·492	70·7	1·7	0·940	S S W.	29·780	74·3	4·3	0·560	S W.	70·7	6·0	0·052	E.	71·0	5·7		W.	29·316	68·0	6·3	·472	57		W.
20	29 277	70·3	2·0	0·240	S.	29·556	73·7	2·0	0·075	(var.)	69·3	1·3	0·250	(var.)	66·3	5·3	0·210	S W.	29·124	60·3	7·7	·424	54	0·140	(var.)
☽ 21	29·434	57·3	16·3		W.	29·729	61·3	12·3		N W.	54·0	13·3		(var.)	51·7	14·7		N W.	29·269	51·3	9 0	·333	48	1·185	S W.
22	29·612	56·0	8·0		S S W.	29·862	61·7	5·7		W.	54·3	12·3		(var.)	55·3	9·7		N W.	29·265	62·7	11·3	·359	50	0·030	S W.
23	29·561	65·7	9·7		S.					S W.	66·7	12·3		W.	63·3	8·0		(var.)	29·322	64·0	1·3	·487	58	0·150	N E.
24	29·442	66·3	1·3		S W.	29·702	71·7			S W.	67·0	1·0		E.	65·0	3·0		(var.)	29·139	70·7	6·7	·424	54		S W.
25	29·242	69·7	3·3	0·020	N W.	29·503	71·7	5·3		N W.	62·0	13·0	0·600	W.	65·7	8·0	0·300	W.	29·089	62·3	8·3	·328	47	0·770	(var.)
26	29·608	57·7	12·0		(var.)	29·868	62·3	9·3		W.	58·7	5·3		W.	58·0	7.7		N W.	29·483	56 3	6·0	·251	40		N W.
27	29·717	49·0	8·7	0·188	(var.)	29·960	54·0	8·3	0·244	(var.)	49·3	9·3		S E.	54·0	2·7		S E.	29·483	58·5	3·3	·314	46		S E.
28	29·662	53·7	4·7		W.	29·882	57·7	5·7		N W.	53·7	4·3		(var.)	50·0	6·7		W.	29·545	52·3	6 0	·187	33	0·070	N E.
○ 29	29·833	49·0	4·7		N W.	30·090	51·0	6·7		N.	42·7	11·0		(var.)	49·0	4·3		N W.	29·686	46·0	6·3	·196	34		E.
30	29·869	46·3	5·3		N W.	30·162	48·7	3·7		N E.	46·0	3.3		(var.)	45·0	4·0		S E.	29·627	48·7	3·3	·216	36		E.
Means	29·563	62·9	5·9	2·733	s 72° w	29·842	66·6	5·5	1·376	s 88° w	60·7	7·7	1·910	s 4° e	60·5	6·4	1·950	n 86° w						3·155	s 74° w

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